ZOOLOGY FOR SCHOOLS.

STANDARD SCHOOL-BOOKS,

PUBLISHED BY

SIMMS & M'INTYRE,

PATERNOSTER-ROW, LONDON; AND DONEGALL-STREET, BELFAST.

	s.	d.
Doisy's (Adelbert) French Grammar, 3rd Edition, 12mo	3	6
„ Recueil Litteraire, 12mo	3	6
Hodges' (Dr. J. F.) Agricultural Chemistry, 9th Ed. 12mo, cl.	3	0
Jackson's Book-keeping, 8vo, sheep	4	0
Knowles's (J. Sheridan) Elocutionist, 19th Edition, 12mo	3	6
Manson's Spelling-Book, 18mo, sheep	0	8
M'Crea's Pronouncing Spelling-Book, 12mo	1	6
Modern Geography Simplified, 2nd Edition, 12mo, cloth	2	0
Mosheim's Ecclesiastical History, by Murdock and Reid, 8vo, cloth	8	0
Murray's Abridgment of English Grammar, 18mo	1	0
„ First Grammar for Junior Classes, 18mo	0	6
Patterson's (R.) Zoology for Schools, 23rd Ed. 12mo, cloth	6	0
„ First Steps to Zoology, 2nd Ed. Pt. 1, 12mo, cl.	1	6
„ „ „ Pt. 2, 12mo, cl.	1	6
„ „ „ Complete	3	0
„ Zoological Sheets, Nos. 1 and 2, each	1	0
Ruddiman's Rudiments of Latin Grammar, 12mo	1	6
Thomson's (Dr. J.) Arithmetic, 38th Edition, 12mo	3	6
„ Key to Arithmetic, 12mo	5	0
„ Geography, 26th Edition, 12mo	3	6
„ Euclid, 8th Edit. Part 1, 12mo, cloth	3	0
„ „ „ Part 2, 12mo, cloth	2	6
„ „ „ Complete	5	0
„ Trigonometry, 5th Edition, 8vo, cloth	4	0
„ Calculus, 3rd Edition, 12mo, cloth	5	6
„ Atlas, 26 maps, 4to, half-bound	8	0
Walker's Dictionary, abridged, 16mo	1	6
„ Pronouncing Dictionary, with Key to Classical Proper Names, 8vo, cloth	4	0

ZOOLOGICAL DIAGRAMS.

Ten Coloured Zoological Diagrams have been prepared by ROBERT PATTERSON, Esq., M.R.I.A., for the Department of Science and Art. The Size of each Diagram is 40½ inches by 29 inches, and the number of Figures contained in the series is 116, illustrative of the principal groups in the Animal Kingdom, according to the classification adopted in the "Zoology for Schools." The drawings have been executed by London artists of the first eminence, they are published by Messrs. DAY & SON, Lithographers to the Queen, Gate Street, Lincoln's-Inn Fields, and may be had of all Booksellers.

Price of the Set of Ten, fully Coloured, £2. 15s.

Single Sheets, 6s. each.

Prospectuses will be forwarded post free on application.

STANDARD SCHOOL-BOOKS,

PUBLISHED BY

SIMMS & M'INTYRE,

PATERNOSTER-ROW, LONDON; AND DONEGALL-STREET, BELFAST.

	S.	D.
Doisy's (Adelbert) French Grammar, 3rd Edition, 12mo	3	6
„ Geography, 26th Edition, 12mo	3	6
„ Euclid, 8th Edit. Part 1, 12mo, cloth	3	0
„ „ „ Part 2, 12mo, cloth	2	6
„ „ „ Complete	5	0
„ Trigonometry, 5th Edition, 8vo, cloth	4	0
„ Calculus, 3rd Edition, 12mo, cloth ...	5	6
„ Atlas, 26 maps, 4to, half-bound	8	0
Walker's Dictionary, abridged, 16mo	1	6
„ Pronouncing Dictionary, with Key to Classical Proper Names, 8vo, cloth.....	4	0



INTRODUCTION

TO

ZOOLOGY,

FOR THE

USE OF SCHOOLS.

BY ROBERT PATTERSON, M.R.I.A.,

EX-PRESIDENT OF THE NATURAL HISTORY AND PHILOSOPHICAL SOCIETY OF BELFAST, ETC.

WITH UPWARDS OF 330 ILLUSTRATIONS, AND A GLOSSARY OF SCIENTIFIC TERMS.

Twenty-third Thousand.

LONDON:

SIMMS AND M'INTYRE,

13 PATERNOSTER ROW; AND 26 DONEGALL STREET, BELFAST.

1857.

PREFACE TO FIRST EDITION.

I HAVE for years been anxious that NATURAL HISTORY should be made a regular Branch of Education, because it exercises both the observant and the reflective powers; furnishes enjoyment pure and exhaustless; and tends to make devotional feelings habitual. The present little Work has been undertaken in the hope that it might conduce to such a result.

In its preparation, I have aimed at conveying correct ideas of the peculiarities of structure by which the principal divisions of the animal kingdom are distinguished; and of the habits, economy, and uses of one or more of the most common native species belonging to each of these groups. Foreign species are occasionally mentioned in connexion with their respective classes, but the "home produce" forms the "staple commodity."

The exercise of memory involved in the repetition of scientific names, or in the recital of anecdotes respecting the animals of the arctic or tropical regions, is, comparatively, of little importance. The great object should be to bring natural-history knowledge home to the personal experience of the pupil. To teach him to observe, to classify his observations, and to reason upon them, and thus to invest with interest the COMMON OBJECTS which he sees around him. Small collections of natural objects, made by the pupils themselves, would, under the guidance of a judicious teacher, be of great value in this species of mental culture, and would form the much-prized ornaments of the school-room.

The present volume has been prepared amid the scanty leisure incidental to the life of a man of business. It will, therefore, I hope, be regarded with indulgence, both by the Naturalist and by him who is practically engaged in the important duties of the school-room.

R. PATTERSON.

Belfast, 3, *College Square North*,
September 5th, 1846.

NOTE.—The illustrations, for the most part, are those employed in the "*Cours Elementaire de Zoologie*" of M. Milne Edwards; a work adopted by the Council of Public Instruction in France.

2090842

PREFACE TO THE PRESENT EDITION.

As Zoological science is progressive, we must expect that, with an increased knowledge of the structure of different groups of animals, there will arise from time to time a necessity for corresponding changes in classification and nomenclature. During the last few years this has, in an especial degree, been the case with regard to the invertebrate animals Erroneous views respecting some of its groups have been corrected; much that was doubtful has been made clear; and affinities, previously unsuspected, have been revealed.

In the present edition some of these conclusions have been indicated, so far as the space available for foot-notes would permit, without disturbance of the pages. Others are omitted as not being suitable for an elementary work; and some because they are as yet undecided, and demand further observation and research. In the text itself scarcely any alterations have been made.

BELFAST, 6 *College Square North.*

CONTENTS.

PART I.—INVERTEBRATE ANIMALS.

Page

Meaning of the Term Zoology 1
Structure, the Basis of Correct Classification 2
Animals arranged in four primary Groups 3

RADIATA, or RAYED ANIMALS.

Meaning of the Term 3
Group divided into four Classes 4
Note respecting two additional Classes 4

CLASS I.—INFUSORIA, or INFUSORY ANIMALCULES.

Their Size and Distribution 5
Arrangement in two Divisions—Advantage of Scientific Terms—*Polygastrica*, or Many-Stomached 6
Experiments of Ehrenberg—Cilia 7
Rotifera, or Wheel-bearing—Their Tenacity of Life—Different Modes of Reproduction among the Infusoria 8
Physical Changes effected through their Agency 10

CLASS II.—ENTOZOA, or INTESTINAL WORMS.

Their Abodes—Variety of Structure—The Tape-worm 12
Multitude of Ova in another Species—These Creatures not produced by Equivocal Generation—Perfection of their Structure 13

CLASS III.—ZOOPHYTA, or POLYPES.

Meaning of these Terms 14
The Class subdivided into four Orders 15
Order I.—Hydroida, or those resembling the Hydra 15
The Fresh-water Hydra 15
Appearance, Habits, and Modes of Reproduction 16
Tubularia, its living Flowers and diffusion of the young Germs 17
Sertulariadæ, or those which resemble miniature Flowers 18
Structure 18
Food, Ova, Numbers, Luminosity 19

Page

ORDER II.—ASTEROIDA, OR STAR-SHAPED POLYPES 20
Sea-pens 20
Sea-fans: their Flexibility 21
Different Structures of the Isis and of the Red Coral 22
ORDER III.—HELIANTHOIDA, OR THOSE LIKE THE SUN-FLOWER ... 22
Sea-anemones 22
Food, Longevity, Use as Barometers 23
Power of enduring Injuries.—Coral-building Polypes 24
Coral Reefs.—Their Extent and Structure 25
ORDER IV.—ASCIDIOIDA, OR ASCIDIAN POLYPES 27
Their Appearance and higher Organization 27
Sea-mats—Their numerous Polypes—Affinity to the Mollusca 28

CLASS IV.—RADIARIA, OR RAYED ANIMALS.

How characterised—their Division into two Orders 29
ORDER I.—ACALEPHÆ, OR SEA-NETTLES 30
Their gelatinous Structure 30
Distribution—*Diphya*—Portuguese Man-of-war 31
Velella—its mimic Fleets 32
Beroës, or Ciliogrades 33
Their Movements, Habits, and Food 34
Luminosity and Transparency 35
Medusæ, or Pulmonigrades—Their Dimensions, Colours, Food 36
Development 37
Large proportion of Fluids in their Bodies 39
Phosphorescence 40
Numbers in the Arctic Sea 41
Utility 42
ORDER II.—ECHINODERMATA, OR STAR-FISHES 42
Their Integument, Transformations 43
Ova and their Development—Variety of Form 44
Stone-lilies, *Crinoideæ*—Their Beauty and former abundance 45
Supposed to be extinct in Europe—Discovery of a living species 46
Sand Star, *Ophiura*—Structure—Diversity 47
"Five-fingers," *Asteriadæ*—Their Suckers and their Uses... 48
Fragility of *Luidia* 49
Sea-Urchin, *Echinus* 50
Mode of Progression—Structure of Shell—Respiration 52
Jaws—Boring power of one Species 53
Sea-cucumber, *Holothuria*—Sipuncular Worms 55

ARTICULATA, OR ARTICULATED ANIMALS.

Characteristics of the Group 57
Its Division into five Classes 58

CLASS I.—ANNELLATA—LEECHES AND WORMS.

Medicinal Leeches—Supply of them 60
Mouth, Stomach, Young 61
Earthworms—Their Food, their Utility—Reproduction in Worms... 62

Page

Lob-worm 64
Respiration in Serpulæ.—Habits of the *Errantes* 65
Sea Long-worm, Sea-mouse 66
Hair-worm, and traditionary Error.—Luminosity of some Annelids 67

CLASS II.—CIRRIPEDA—BARNACLES AND ACORN SHELLS.

Tradition respecting Barnacles 69
Young state of Barnacles and of Acorn-shells 70
Their Transformations.—Formerly classed with Mollusca 71
Cheapness of the Pleasures of Natural History 72

CLASS III.—CRUSTACEA—CRABS, LOBSTERS, SHRIMPS, &c.

Name, Distribution, Form, Characteristics 73
Reproduction, Respiration 74
Vision, Eyes of Trilobites 77
Metamorphoses 78
Land-crabs 80
Classification.—*Limulus* or King Crab 81
Spider-crabs 82
Edible Crabs 83
Pea Crabs.—Hermit Crabs 84
Lobster.—Spiny Lobster 85
Cray-fish: its Food, Habits, Change of Shell 86
Shrimps.—Prawn 88
Sand-hopper.—Cyclops 89
Daphnia.—Limnoria 90
Lernæa.—Opossum Shrimp, as shown by the Microscope 91

CLASS IV.—INSECTA—INSECTS.

External Structure 93
Circulation and Respiration 94
Nervous System 96
Senses 97
Metamorphoses 100
Food, Digestive System 103
Mouth 104
Wings and Wing-covers 105
Enumeration of the several Orders 106
ORDER I.—COLEOPTERA—BEETLES 107
Great Water Beetle.—Death-watch 107
Glow-worm.—Dor-beetle 108
Sacred Beetle.—Tiger Beetle 109
Cockchafer.—Nut Weevil 110
Burying Beetle.—Number of Coleoptera 111
ORDER II.—ORTHOPTERA—CRICKETS, LOCUSTS, ETC. 112
Leaf Insects 112
Mantis 113
Crickets.—Cockroach 114
Locust 115

Page
Beak and Ink-bag.—Belemnite.—Its Carnivorous Habits 186
Argonaut, or Paper Nautilus 187
Poetic Descriptions of it.—Its Nautical Powers fabulous.—Its real Movements, and the true Functions of the Supposed Sails..... 188
Octopus.—Its Arms.—Suckers 189
Powers of Attack and Escape.—Change of Colour.—Ink of the Cuttle-fish.—Its flesh used as Food 190
Value as Bait.—Numbers.—Gigantic Cuttle-fish.—Ova 191
Fossil Remains.—Geological Importance of the Mollusca 192
Recent Investigations on the Microscopic Structure of Shell..... 193
Mollusca and Radiata of the Ægean Sea.—Regions of Depth..... 193
Philosophy of the Study 194

CONTENTS.

PART II.—VERTEBRATE ANIMALS.

	Page
Vertebrate Animals, how characterized	195
The Skeleton—Composition of Bone	196
Division of Vertebrate Animals into Four Classes	196

CLASS I.—PISCES—FISHES.

Definition, and Distinctive Characters	197
Distribution.—Extremes of Temperature at which they live	197
Form—its great variety—Change by Inflation	198
Covering—Scales—Mucus—Brilliancy of Colour	199
Bony plates of the Trunk-fish and Pipe-fishes	200
Senses—Cirri, Organs of Touch	200
Taste—Smell—Hearing—Sight	201
Blind-fish—Absence of Eyelids—Colours of the Eyes	202
Locomotion—Swim-bladder—its Uses—not universal	202
Caudal-fin—other Fins how named	204
Variety of Movement observed in a Pipe-fish	205
Flying Fish	206
Respiration—Heart—Gills—What kills a Fish when out of Water	207
Food—Some Fishes live on Vegetables, but most of them on Flesh	207
Beneficence of this Arrangement—Voracity of Fishes	209
Teeth—their Variety, Uses, and Numbers	210
Reproduction	212
Preservation of Vitality in the Ova	212
Distribution, Geographical—also according to Zones of Depth	212
Number of Ova—Instances of Parental Care of the Spawn	213
Means of Escape, Defence, and Attack	214
Uniformity of Colour—Flight—Spines	215
Weapons of the Spined Dog-fish	215
Weapons of the Stickle-back, Saw-fish, and Sword-fish	216

Page
Electric Fishes—Scene described by Humboldt 218
Powers of Vitality and its connexion with Structure and Habits ... 218
Errors and Traditions—Mackerel Midge—Eels—Maigre—Dory—
Remora 219
Classification—Table of Cuvier's Arrangement 221

CARTILAGINOUS FISHES.

Order Cyclostomi—Lampreys 223
The Lancelet—Its Structure—Carnivorous Habits 223

Order Plagiostomi—Sharks and Rays 224
Egg-bags of the Sharks and Rays 224
Native Dog-fishes—Foreign Sharks 225
Basking Shark—Examples of Beneficent Design 226

Order Sturiones—Sturgeons 227
Form of the Tail—A "Royal Fish"—Its great Size 227

OSSEOUS FISHES.

Order Plectognathi—Globe-fishes 228

Order Lophobranchii—Pipe-Fishes 228
Hippocampus—Marsupial Pouch of the Male Pipe-fish 228

Order Malacopterygii Apodes—Eels..... 229
Sand Eels—Conger Eel..... 229
Fresh-water Eels—Susceptibility to Cold 230

Order Malacopterygii Sub-Brachiales 231
Peculiarity of Structure in the Lump-Sucker 231
The Plaice—The Turbot 232
The Cod—Newfoundland Fishery 233

Order Malacopterygii Abdominales 233
The Whitebait—Sprat—Pilchard—Herring 233
Migrations of the Herring—Of the Pilchard 234
Salmonidæ.—The Family of the Salmon 236
The Pollan of Lough Neagh—Its Abundance 236

Page
The Common and Great Lake Trout—Varieties of the Former 236
Migration of the Salmon—Salmon Fishery near Coleraine 237
Growth of the Salmon—Change in its Markings 238
The Pike—its Voracity—Value—Longevity 239
The Carp—"Gold and Silver Fishes"—Bream 240

ORDER ACANTHOPTERYGII (Fins with Spiny Rays) 241
The Wrasse—Fishing Frog—Gobies and Blennies 241
The Mullet—Grey Mullet of Belfast Bay 242
Riband-shaped Fishes—Red-band Fish..... 242
Pilot Fish—Tunny—its High Temperature 243
Mackerel—Gurnards 244
Perch—its former Value—its Habits 245
Lepidosiren—Is it a Reptile or a Fish?—its Habits..... 246
Fossil Fishes—their Arrangement in Four Primary Groups—Singular Forms and Covering of the Fossil Fishes of the Old Red Sandstone 246

NOTE.—On the Improvement of Fisheries and the Education of Fishermen 247

CLASS II.—REPTILIA—REPTILES.

Characteristics of the Class—Variety of Form and Structure 249
Number of Species—Their Division into Four Orders 249
Geographical Distribution—Why Reptiles are Cold-blooded..... 250

ORDER I.—AMPHIBIA—AMPHIBIOUS REPTILES 251
Consist of Two Groups—The Axolotl 252
The Common Frog—Its Metamorphoses—Food 253
Tree Frogs—Respiration—Torpidity—The Common Toad 254
Metamorphosis of the Newts—Their Carnivorous Habits... 255
Errors respecting the Toad—Footprints of Gigantic Batrachian Reptiles 256

ORDER II.—OPHIDIA—SERPENTS..... 258
Their Flexibility—Number of Species—Distribution 259
Boa-Constrictor—Jaws of the Snake—Poison Fangs of Rattle-snake 260
Egyptian Naja—The Cobra-di-Capello—Anecdote of one 261
Incubation observed in a Serpent—Former Existence of Pythons and Boa-Constrictors in England..... 262
English Adder and Common Snake—Habits—Movements 263
Supposed virtues of the flesh—Blind Worm—Altitude at which some are found..... 264

Page

ORDER III.—SAURIA—LIZARDS 265
Characteristics—Numbers—Use as Food—Habits 265
Iguana—Gecko—Chameleon 266
Change of Colour in the Chameleon, how explained..... 267
British Lizards—Anecdote of a Sardinian Species 268
Crocodile—Its Utility—Errors respecting it 269
Extinct Species of British Saurian Reptiles 271

ORDER IV.—TESTUDINATA—TORTOISES 273
How distinguished—Structure of the Shield or Covering ... 274
Number of Species—Their Classification 275
Hawk-billed Turtle—Ease and Celerity of its Movements 275
Habits of Different Species..... 276
Longevity—Tortoises of the Galipagos Archipelago 277
Gigantic Fossil Tortoise of India 278
Former abundance of Tortoises in the British Seas..... 279
A Tortoise in Love..... 280

CLASS III.—AVES—BIRDS.

Definition—Power of Flight 281
Peculiarities observable in the Structure of the Skeleton 282
Circulation of the Blood, and its high Temperature 286
Covering—Variety in the Plumage 287
Long-continued Power of Flight—The Frigate Bird 289
Buoyancy of the Gannet—Its great Abundance in some Localities 291
Impetus of its Descent—Mechanism for this Purpose 292
Moulting—Meaning of the Term—Explanation of the Phenomenon 293
Digestive Organs—The Bill—Crop—Gizzard 294
Sense of Sight 297
Sense of Smell—Turkey—Buzzard—Condor..... 298
Removal of decaying Animal Matter 300
Migration—Power of the Migratory Instinct 301
Affection of Birds for their Young 303
Nests—Examples of the Variety in their Structure 304
Organs of Voice 306
Geographical Distribution—Classification 308

ORDER I.—RAPTORES—BIRDS OF PREY 311
VULTURES.—Griffon and Egyptian Vulture 312
The Condor—its Size and Flight—The Lammergeyer 313
FALCONS.—What birds are included in the family *Falconidæ* 314
Eagles—The Spotted—The Sea Eagle 315
The Golden Eagle—its Habits 316
The true Falcons—The Peregrine 319
Falconry—Terms Employed—Training of the Falcons 320
Their Former Value—Flight—Courage..... 321

Page
The Gos-Hawk—Sparrow-Hawk—Kite—Harriers 323
Owls.—Their Flight—Difference in Size 324
Habits of the White Owl—The Eagle Owl 325

Order II.—Insessores—Perching Birds..... 326
Meaning of the Term—Mechanism by which Birds are enabled to Perch 326
Division of the Order into Four Tribes 327

Tribe I.—Dentirostres—Tooth-billed Birds 328
Butcher Birds—Water Ouzel—Missel Thrush 328
Robin Red-breast—Habits—Nests in Strange Situations... 330
Nightingale—Distribution—Song—Humming-Birds 331

Tribe II.—Conirostres—Conical-billed Birds 333
The Sky-Lark—Buntings—Sparrows—Linnets—Cross-bill 333
The Starling—Its Migratory Habits—Large Flocks 335
Birds of Paradise—Fables respecting them 336
The Raven—Hooded Crows—Rooks—Nest-building 337
Are Rooks Useful or Injurious to the Farmer? 339
Magpie—Jackdaw—Jay—Horn-Bills 340

Tribe III.—Scansores—Climbing Birds 341
Parrots—Woodpecker—Structure of the Tongue 341
The Cuckoo—Its Habits—Its Cheerful Note 342

Tribe IV.—Fissirostres—Gaping-billed Birds 344
The King-fisher—Fables respecting it 344
The Goatsucker—The Swallow 345
House Martins—Their Punishment of an Intruder—Sand-Martin—Swift 346

Order III.—Rasores—Scraping-Birds 347
Meaning of the Term—Native Species arranged in Four Families 347
I.—Doves.—Wood-Pigeon—Its Large Flocks—Food..... 347
Carrier-Pigeon—Rapidity of its Flight—Passenger-Pigeon—Its immense Flocks 348
II.—Pheasants.—Common Pheasant 349
III.—The Grouse.—Red Grouse—Black Grouse 349
Ptarmigan—Its Change of Colour—Partridge—Quails—Their Numbers—The Capercaillie 350
IV.—Bustards 351

Page

ORDER IV.—GRALLATORES—WADING BIRDS 351
Meaning of the Scientific Term 351
The Apteryx—The Plover 352
The Lapwing—Crane—Heron 353
The Bittern—Its Booming—Its Haunts 354
The Stork—Ibis—Woodcock 355
Land and Water Rails—Water-hen—Coot 356

ORDER V.—NATATORES—SWIMMING BIRDS 356
Flamingo—Its Peculiarities 357
Division of the Order into Five Families 358
I. *Anatidæ*.—The Family of the Duck 358
Wild Geese—The Bernicles and Brent Goose 358
Wild Swans—Mute Swan—Black Swan—Eider Duck 359
II. *Colymbidæ*.—The Family of the Divers 360
III. *Alcidæ*.—The Family of the Puffins—Penguins 361
IV. *Pelecanidæ*.—The Family of the Pelicans 361
Solan Goose—Cormorant 361
V. *Laridæ*.—The Family of the Gulls 362
Terns or Sea Swallows 362
Habits and Haunts of Sea-Gulls 363
Petrels—The Stormy Petrel 364
Value of Petrels in some Localities 365
Vast Multitudes off the Coast of Patagonia 366
Birds now Extinct—The Dodo 366
Its Figure—Unexpected Affinity to the Pigeons 367
Gigantic Wingless Birds of New Zealand—*Dinornis* 367
Hypothesis suggested by their Size and Number 368

CLASS IV.—MAMMALIA—QUADRUPEDS, &c.

Meaning of the term *Mammalia*—Circulation—Respiration 369
Covering—Skeleton 371
Appendages of the Head—Horns 373
Tusks—Whalebone 375
Teeth—Their Diversity in Number, Form, and Structure 376
Dependence of one part of the Animal Frame on another 378
Classification of Mammalia in Eleven Orders 379

ORDER I.—MARSUPIATA—POUCHED ANIMALS 381
Meaning of the Term—Animals included in the Order 381
Geographical Distribution—Peculiarities connected with the Young 382
Number of Species—Diversity of Size and Structure 383
Ornithoryncus—Kangaroos—Opossums 384

Page

ORDER II.—RODENTIA—GNAWING ANIMALS 386
Characteristics—Distribution 387
Molar Teeth—Growth of the Incisor Teeth 388
Hybernation—Utility 389
Squirrel—Hare—Beaver 391

ORDER III.—EDENTATA—TOOTHLESS ANIMALS 392
Characteristics of the Order—How divided 392
Armadillos—Their Range and Habits—Sloths..... 393
Unau or Two-toed Sloth—Its Mode of Progression 394
Megatherium—Mylodon..... 395

ORDER IV.—RUMINANTIA—RUMINATING ANIMALS 398
Characteristics—Sub-division—Distribution—Utility 398
The Camel—The Llama..... 401
The Musk Deer—Native Deer 401
Giraffe or Camelopard 402
Antelopes—Chamois—Gazelle—Goat 403
Sheep—Elevation at which Species are found 404
Ox—Buffalo—Bison 404
Extinct Species of Oxen..... 404

ORDER V.—PACHYDERMATA—THICK-SKINNED ANIMALS. 405
Hippopotamus—Rhinoceros—Swine—Tapir—Horse 406
Elephant—Its Food—Structure and Development of its Teeth 407
Distinctive Characters exhibited by the Teeth 408
Evidence of the Former Existence of Elephants and other Pachydermata in Britain..... 410

ORDER VI.—CETACEA—WHALES—DOLPHINS—PORPOISES 411
Characteristics.—Division into Groups 411
Dolphin—Porpoise—Bottle-head Whale 412
Cachalot or Spermaceti Whale 412
Common or Baleen Whale..... 413
Tail—Structure of "Blubber." Its uses to the animal..... 414

ORDER VII.—CARNIVORA—FLESH-EATING ANIMALS 416
Characteristics—Number of Species 417
Seals—Bears 418
Badger—Otter—Weasel—Ferret—Stoat 419
Dog—Fox—Wolf 419
Feline Animals—"Great Cave Tiger," formerly in England 420
Cave of Hyænas in Yorkshire 420
Brevity of the Life, not of Individuals, but of Species 421
How came Elephants, Bears, Tigers, &c. into England? ... 421

Page

ORDER VIII.—INSECTIVORA—INSECT-EATING ANIMALS ... 422
Form of the Teeth—"Shrew-mouse"—Hedgehog 422
The Mole—Its Structure—Food—Habits 423

ORDER IX.—CHEIROPTERA—BATS 424
Structure of the Wing—Its exquisite Sensibility 424
Leaf-like Organs of Smell—Number of Species—Vampire 426

ORDER X.—QUADRUMANA—MONKEYS 427
Characteristics and Divisions of the Group 427
Lemurs—Oustiti, and other American Species 428
Barbary Baboon—Asiatic Monkeys 429
Distinguishing peculiarities of Baboons, Monkeys, and Apes 430
Chimpanzee—Number of Species—Fossil Remains 431

ORDER XI.—BIMANA—MAN 432
His erect Gait—Structure of the Hand 432
Position in the animal kingdom—Intellectual faculties 434
Responsibility for the Right Employment of his Powers ... 434
Advantages of Zoological Study—Conclusion 434

INTRODUCTION TO ZOOLOGY,

FOR THE

USE OF SCHOOLS.

"These are thy glorious works, Parent of good—
Almighty! Thine this universal frame,
Thus wondrous fair: Thyself how wondrous then,
Unspeakable! who sit'st above the heavens—
To us invisible, or dimly seen
In these thy lowest works; yet these declare
Thy goodness beyond thought, and power divine."—MILTON

THE word "Zoology" is derived from two Greek words, and signifies a knowledge of animals. The science which teaches the structure, habits, and classification of animals is *Zoology:* the person by whom such knowledge has been acquired is a *Zoologist.*

When we regard man as the head of the animal creation, and trace the various gradations of structure and intelligence between him and some of the humblest organized tribes of being; or when we think of the countless multitudes of animals scattered over the earth, and diffused throughout its waters, it might seem that any attempt to form them into groups, to distinguish the several species, and bestow on them appropriate names, would be altogether unavailing.

But what the labour of an individual would be insufficient to effect, the combined exertions of many are, in the course of time, able to accomplish; and as man possesses the power of transmitting by writing the knowledge he has acquired, we are enabled to benefit by the toil and exertion of those who have gone before us, and take advantage of the materials which their industry has collected.

The first and most obvious thing to be done is, to fix upon some good distinguishing marks by which the principal groups of animals may be separated from each other. This would,

at first sight, appear an easy matter. Thus, birds might be distinguished by the power of flight, and fishes by that of living and swimming in the water. But a little attention would show, that such characteristics would, in both cases, lead to erroneous results. The Bat flies in the air, yet it brings forth its young alive and suckles them as the domestic cat would do. The Whale lives in the sea; but, while in the fish the heart has only two compartments, the blood is cold, and respiration is effected by gills, the Whale has a heart furnished, like that of the Ox, with four compartments, the blood is warm, and breathing is carried on by lungs. The fish deposits its spawn, and the young, when liberated from the eggs, provide for themselves according to their several instincts. The young of the Whale, on the contrary, are brought forth alive, are objects of maternal solicitude, and are suckled with affectionate assiduity. The Bat, though flying in the air, is not therefore a bird; the Whale, though swimming in the sea, is not therefore a fish. They both belong to the same division as our large domestic quadrupeds, which, from the circumstance of their suckling their young, are grouped together by the expressive term "Mammalia."

It is obvious, therefore, that *structure* must form the basis of classification. And in the present state of our knowledge, it is no less obvious that arrangements, based on the structure of one particular organ, or one series of organs, to the exclusion of others, would be incomplete, and would lead to error. All organs must be considered, and internal as well as external structure must be examined, before any true systematic arrangement can be attained; and this will be complete, exactly in proportion to the extent and the accuracy of our knowledge. The great object is, to arrange animals in such a way as to exhibit their true affinities to each other, and to embody, with regard to each group, the most comprehensive truths regarding them which the conjoined labours of eminent men have as yet elicited.

Lamarck, a distinguished French naturalist, proposed arranging all animals according to the presence or absence of a skull and a backbone or vertebral column; and this division is so convenient and so obvious that it is still retained. But Baron Cuvier pointed out, that great and important differences exist among the invertebrate animals, or those which are destitute of a skull and vertebral column—dif-

ferences so great as to justify a further subdivision; and that, according to the modifications of the nervous system, the entire animal kingdom might be divided into four primary groups,—one of them consisting of the vertebrated animals, and three of those which are invertebrated. Adopting these views, we follow the illustrious Cuvier in dividing the whole animal kingdom into four great groups, or sub-kingdoms; namely,—

I. Vertebrated animals, or *Vertebrata;*

[INVERTEBRATA.]

II. Soft-bodied animals, or *Mollusca;*
III. Articulated animals, or *Articulata;*
IV. Radiated animals, or *Radiata.*

To begin with those at the foot of the scale and gradually ascend, is the best mode of preparing to enter with advantage on the consideration of the higher ranks of organized beings. Our attention should, therefore, be directed, in the first place, to the Radiated animals.

RADIATED ANIMALS.

"O Lord, how manifold are thy works! in wisdom hast thou made them all: the earth is full of thy riches: so is this great and wide sea, wherein are things creeping innumerable, both small and great beasts."—PSALMS.

If we pick up a common star-fish, which has been left upon the beach by the retiring tide, we notice that the limbs or arms of the animal are like radii, diverging from a common centre, or like rays surrounding a central disc. From this circumstance it is termed a "rayed" or "radiated" animal.

In other species belonging to the same great class, the radiated structure is not at first sight so obvious. It will, however, be easily detected in the sea-urchin (*echinus*), although the outline of the animal is so different. In others, it will be found, not in the general aspect of the body, but in the radiated arrangement of the parts surrounding the mouth. Wherever, throughout this division of the animal kingdom, we are able to trace in the body the existence of a nervous

system, it partakes of that radiated appearance which, in some species, is presented by the external figure. Some creatures, in which no nervous system has as yet been discovered, are included in this division; and as our knowledge of their structure and habits is increased, our present classification must be revised, and perhaps amended.

The Radiated animals may be treated of under four primary divisions or "classes," in each of which there are found animals of a higher and a lower grade of organization, *viz.*:—

Infusoria, or Infusory Animalcules;
Entozoa, or Internal Parasites;
Zoophyta, or Polypes;
Radiaria, or Rayed Animals.

For recent additions to these *vide* foot-note.

Class INFUSORIA, or INFUSORY ANIMALCULES.

"Where the pool
Stands mantled o'er with green, invisible
Amid the floating verdure millions stray."—Thomson.

If any vegetable substance be allowed to remain for about ten days in a glass of water, exposed in a window to the rays of the sun, the water will appear to the naked eye to have undergone little change. But if a drop be taken from the surface and placed under the microscope, it will exhibit such a multitude of living beings swimming about, that the spectacle cannot be looked upon for the first time without surprise, and even astonishment. Nor is the feeling of wonder diminished when we endeavour to calculate their size, and form some estimate of their numbers. If a drop of the water

Note.—*Nov.* 1856.—To these, two other Classes containing animals of lower organization may now be added. One of these, the *Foraminifera*—Latin *foramen*, a hole—contains the minute chambered shells mentioned in page 157. These shells are perforated, and as if covered with pores. The body is gelatinous and furnished with retractile root-like processes, by which these animals are said to imbibe nourishment, and also to swim and crawl—hence the term *Rhizopod*, or "root-footed." The other class comprises sponges, now generally regarded as members of the animal kingdom. The name *Amorphozoa*, implies that they are animals without regularity of form.

containing them be placed between two pieces of glass, they will be seen swimming about with perfect ease in that little film of liquid, and passing and repassing without even coming

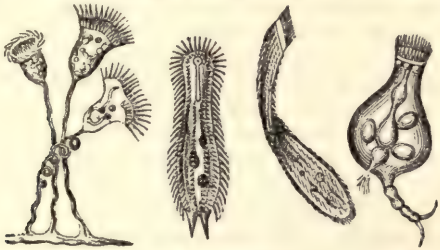


Fig. 1.—Infusoria.

into contact. The globules of blood in the human body are variously estimated in regard to size, but when magnified 180,000 times do not exhibit an image larger than the accompanying figure. Many of the infusory animalcules are, however, still more minute, so that 180,000 of them, if formed into a ball and laid upon the paper, would cover even a smaller surface.

Professor Ehrenberg, of Berlin, has calculated, that 2,000 of them placed together would measure but one line, or the twelfth part of an inch. According to this estimate, a single drop of water might contain 500 millions of these minute animals: a number nearly equalling that of the whole human species now existing on the earth!

But although these animalcules abound in infusions of animal or vegetable matter—whence their name *infusoria*—they are not restricted to such situations. They are numerous in all countries, and are found in all waters; not merely in those of the stagnant pool, but in lakes, in rivers, and in the sea itself. From materials furnished to him by the late antarctic expedition, Ehrenberg* has ascertained that they exist even in the ice and snow of the polar sea, and that they are abundant not only in inland seas, and in the vicinity of land, but that the clearest and purest water, taken from the open sea, and far from land, is crowded with microscopic life. These minute organisms have been found living at the depth of 270 fathoms

Fig. 1.—Four common native species, viz. I. *Vorticella convallaria.* II. *Chaetonotus larus.* III. *Leucophrys spatula.* IV. *Lepadella ovalis.*

* Ehrenberg on Microscopic Life in the Ocean at the South Pole, and at considerable depths.—Annals Nat. Hist. Sept. 1844. Page 169.

(1,620 feet), and, consequently, subjected to a pressure equal to 50 atmospheres.* Nor are they bounded even by these localities, for they have been discovered in the cells of plants, and in other situations where, but a few years ago, their presence would not have been suspected.

As they are so widely diffused, and must, in such variety of circumstances, subsist on very different kinds of food, it may naturally be expected that they must present very considerable diversity of size, form, and structure. These differences furnish means by which species can be distinguished from each other; the agreement of several species in some one common character enables the naturalist to combine them into one genus; and, by a repetition of the same process, to unite several genera into one larger group, on which some common and characteristic name is bestowed. In this way, the whole of the Infusoria may be arranged in two great divisions. The characteristic of the first of these is the presence in the body of the creature of what Ehrenberg regarded as a number of sacs, or stomachs; and from this peculiarity the order was called by him *Polygastrica*, or "many-stomached" (*Fig.* 2). In the second order, instead of this peculiarity, there is another not less remarkable. About the head there are rounded lobes, which, when looked at under the microscope, seem like wheels in rapid motion; and hence the creatures in which this was observed were called "wheel-animalcules," and the order itself *Rotifera*, or "wheel-bearing." The parts do not in reality move like wheels, but the movements of the delicate hair-like organs with which they are fringed make them seem to do so.

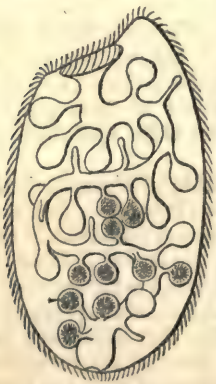


Fig. 2.—Leucophrys.

The use of scientific terms has something in it very repulsive to the young naturalist. But this often arises from the terms being used without any precise idea of their meaning being conveyed to the mind of the learner. When any term is thoroughly understood, there is an end of the

* About 750 lbs. on each square inch of surface.

difficulty; and the word once known, it is not readily forgotten. In the preceding instance, we have explained the meaning of the words Polygastrica and Rotifera, so that we hope there will not be anything difficult or obscure in their use hereafter. We shall endeavour to do the same with such other scientific terms as we may have occasion to employ. Their number is few, and they are of such great utility that the acquisition of them is worthy of a little effort. By such means we can indicate to a person in a remote country, and speaking a foreign language, the very animal regarding which we have any fact to communicate; and, in like manner, we can know with certainty of what animal observations made in other parts of the world are recorded. The terms of science are common to the men of science in all countries; and, if the terms be correctly applied, no doubt or ambiguity can arise. They furnish us with the means of expressing the ideas we wish to convey, with a precision otherwise unattainable; and the habitual use of them assists in giving precision to the ideas themselves, and thus forms a help in that mental process which the mind of the naturalist must undergo in the acquisition of knowledge.

It may naturally be asked how, in beings so inconceivably minute as the Polygastrica, the existence of cells or "stomachs" could be discovered. The plan adopted by Ehrenberg for this purpose was ingenious:—The professor removed some of them from the water in which they were found, and placed them in water of the purest and most transparent description, and, after having subjected them to a fast for some time, he put into it an infusion of indigo or carmine which tinged the water. When they began to feed, he found, as the "stomachs" filled, they became visible by the blue or red particles shining through their transparent skins. The bodies of the Polygastrica are furnished with fine hair-like appendages, termed *cilia;** these are scattered over the surface, and by their continual movement propel the little animals through the water, and bring within their reach the particles of decaying vegetable matter on which they live. There is reason to believe that these singular organs of locomotion are not put into activity by the will of the animal; and hence that their movement, like that of the human heart, might continue for any length of time without inducing a feeling of fatigue. This

* The Latin word for eyelashes.

idea receives confirmation from the fact, that by day or night, at whatever period the Polygastrica may be examined, the observer will never find them in a state of repose, or witness them roused to activity by the light.

The Rotifera present a higher organization than the Polygastrica. In them we can trace a nervous system; and we observe muscular bands running over the body, both longitudinally and transversely, by means of which they can expand or contract their bodies in any direction (*Fig.* 3). The cilia, already mentioned as fringing the lobes on the upper portion of their bodies, by their ceaseless action cause currents in the water, and thus furnish a supply of food, while, at the same time, they act as instruments of progression. The Rotifera feed on the Polygastrica; and they are furnished with an instrument by which they can attach themselves to one spot, and thus, when not inclined to swim about, they can moor themselves at pleasure, and feed at their ease on the nutriment which the currents caused by the action of the cilia bring within their reach. The Rotifera are remarkable for their tenacity of life. Fontana, an Italian naturalist, kept a number of them for two years and a half in dried sand; yet, in two hours after the application of rain water, the greater part recovered life and motion. Spallanzani repeated the experiments with similar results, after having kept the creatures for four years in the torpid state. He further proved their power of revival after apparent death, by alternately drying and moistening the same individuals. He tried this fifteen times; at each exhumation some of the animalcules did not recover—after the sixteenth time, none of them revived.



Fig. 3.—Hydatina.

The different modes of reproduction among the Infusoria are very remarkable. Some are produced from gems or buds. These appear like little tubercles on the body of the parent—increase in size—assume the form proper to the species—drop off, and become perfect and distinct animals. This mode is

called *gemmiparous*. Another, which may seem more wonderful, is by the division of the body of the parent into parts, each part becoming a distinct animal, and, by a like process, giving life to numerous others. This mode, which has been termed the *fissiparous*,* "is amazingly productive, and indeed far surpasses in fertility any other with which we are acquainted, not excepting the most prolific insects, or even fishes. Thus, the *Paramecium aurelia*, if well supplied with food, has been observed to divide every twenty-four hours; so that, in a fortnight, allowing the product of each division to multiply at the same rate, 16,384 animalcules would be produced from the same stock, and in four weeks the astonishing number of 268,435,456 new beings would result from a continued repetition of the process. We shall feel but little surprised, therefore, that, with such powers of increase, these minute creatures soon become diffused in countless myriads through the waters adapted to their habits."†

There is yet another mode of propagation among the Infusoria, the *oviparous*, or that from *ova* or eggs. As the ditches in which they live dry up in Summer, the animalcules perish; but, prior to this, the mature ova burst through the skin of the parent, and thus the last act of the creature's life is to provide for the continuance of the species, by depositing thousands of fertile germs. These are lifted up by the winds, are dispersed through the atmosphere, and float in the air, ready to assume the functions of active life, so soon as they are placed in circumstances favourable for its development.

When we reflect upon the singular structure "of these miniature existences, small almost to invisibility,"‡ and on the providential care evinced in maintaining, by such varied means, the continuance of the species, we see "that greatness and littleness make no difference to God in his creation or his providence." They reveal to us that "magnitude is nothing in His sight; that He is pleased to frame and to regard the small and weak as benignly and as attentively as the mighty and the massive." On further investigation, it would be no less obvious that these minute and insignificant creatures are made the humble instruments of great benefits to man, and of important physical changes on the surface of the globe.

* Latin, *fissus*, divided; *pario*, I produce.
† Jones' Outlines of the Animal Kingdom.
‡ Sharon Turner's Sacred History of the World.

Existing as they do, everywhere in countless multitudes, and endowed with appetites so voracious, it is clear that they are well adapted to be the unseen scavengers of nature, and that one of their uses in creation is to remove those decaying matters which would become offensive to our senses and dangerous to human life. Having removed those dead and decaying substances, and made them a part of their own organization, they in their turn become food for other animalcules, which again serve as nourishment for fishes. They form, therefore, one of the means by which the salubrity of our atmosphere is preserved, and putrefaction and decay rendered conducive, through their instrumentality, to the support of higher animals, and thus to the sustenance of man himself.

Some species of the polygastric animalcules, notwithstanding their minuteness, are furnished with shells of various forms and sizes. These are generally formed of silex; and though not displaying the rich colours of the shells of the mollusca, are no less beautiful, for the place of colour is supplied by the most varied and exquisite patterns of natural sculpture (*Fig.* 4).

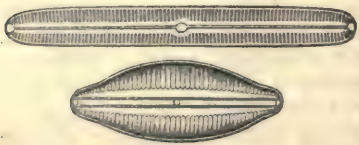


Fig. 4.—Shells of Infusoria.

The large aggregation of them in different parts of the world is perhaps the most surprising circumstance in their history. Ehrenberg found that a hill in Bohemia, composed chiefly of the polishing substance known in the arts as "tripoli," was one mass of the siliceous fossil shells of these creatures; and that, in a stratum fourteen feet in thickness, a cubic inch contained the remains of 41,000,000,000 of individuals. On the shores of a lake near Urania, in Sweden, is found a deposit of a similar kind, called by the peasants "mountain-meal," and which they use mixed up with flour as an article of food. Deposits of fossil infusoria are not confined to foreign countries. A few years since, the Bann Reservoir Company were deepening a small lake a few miles from Newcastle, in the county of Down, and the workmen found a

white deposit at the bottom of the excavation. It proved to be an excellent material for cleaning and polishing plate; and, on subsequent examination, under the microscope of an Irish naturalist, was discovered to consist of fossil Infusoria.* The accumulation of similar deposits is at present producing important changes in the bed of the Nile, at Dongola in Nubia, and in the Elbe at Cuxhaven; it is even choking up some of the harbours in the Baltic sea.†

When we consider the diminutive size of these creatures, the stupendous monuments which they leave behind, and the mighty changes which their unseen labours are silently effecting, we must admit the justice of Ehrenberg's remark: "Truly indeed the microscopic organisms are very inferior, in individual energy, to lions and elephants; but, in their united influences, they are far more important than all these animals."

NOTE.—May, 1854. A beautifully illustrated work, of great scientific interest, has recently been published by the Rev. Wm. Smith, on these minute shell-producing organisms (*Diatomaceæ*). From this it appears that their mode of reproduction is altogether of a vegetable character, analogous to that of the *Algæ*, or water plants. According to these views, the organisms by which the minute siliceous skeletons are produced should be excluded from zoological works. The facts stated in former editions respecting them are, however, allowed to remain, as their value is not affected by any change of opinion respecting the nature of the organisms by which they are deposited.

CLASS ENTOZOA, OR INTERNAL PARASITES.

"Verily, for mine owne part, the more I looke into Nature's workes, the sooner am I induced to beleeve of her, even those things that seem incredible."—HOLLAND'S PLINY.

THE body of every vertebrate animal forms the abode of many other animals that live within it. These creatures constitute the class *Entozoa*, a word which simply means "within an animal," and is very appropriate to the internal parasites, which constitute the present group.

With this class we are as yet imperfectly acquainted; but some idea of its numbers may be formed from the fact, that no species of animal is supposed to be exempt from their attacks, and that the human body is infested with no less than eighteen species. It is stated that every animal has one

* Drummond in Mag. Nat. Hist. 1839.

† Ehrenberg in Edinburgh Phil Journal, vol. xxxi. p. 386.

or more species peculiar to itself. If so, the number of species among the Entozoa must exceed that of all other animals existing in the world.

These singular beings differ widely in their structure. Some, resembling delicate transparent membranes filled with water (*Fig.* 5), appear more simple than any of the Infusoria; others are so complex, that, in some respects, they seem allied to animals of a much higher rank in organization. Many details pertaining to their abode, their nutriment, and their means of increase, though interesting to the naturalist, and important to the physician, would here be out of place. But as the Entozoa constitute one class of the animal kingdom, and cannot, therefore, be passed over in silence, a brief notice of some of their peculiarities may be inserted.



Fig. 5.—Cystic Entozoon.

They are found in the stomach, in the intestines, in the bronchial tubes, in the biliary ducts, and even in the humours of the eye. The farmer is well acquainted with two kinds, one of which exists in the brain and the other in the liver of the sheep. One species, which infests the human body, is the common Tape-worm (*Tænia solium*, *Fig.* 6), which is occasionally found several yards in length. Its head is furnished with four suckers and two rows of recurved bristles, by means of which it is enabled to fix itself securely to any spot it selects. The most singular trait in the structure of the creature is the multitude of its joints, and the power which each of these joints possesses of producing thousands of fertile ova. When these ova come to maturity, the lower segment of its body breaks off from the upper: the Tape-worm may, from this peculiarity, be compared to trees or plants which fling off their seeds when they come to maturity. When the lower segment of the worm separates from the upper portion, the

Fig. 5.—*a*, *Cysticercus cellulosæ*, **magnified.**—*b*, **the head still further enlarged.**

Note.—It is this species which, when abundant, gives to the flesh of the Pig the appearance termed *measles*, or *measly*. The *Cysticerci* are now regarded as the larvæ of *Tæniæ*, and not as mature or perfect animals. Note p. 56.

last joint of the upper gradually lengthens and becomes two joints. The then lowermost joint in the same manner becomes elongated, and divides into two; and by a repetition of the same process the animal, in a short time, regains its original length. In *Ascaris lumbricoïdes*, the most common intestinal parasite of the human body, Dr. Eschright had estimated the number of ova, which one mature female contained, at 64,000,000. When creatures of structure and habits so singular were first found in the bodies of birds, fishes, quadrupeds, and other animals, it was naturally a subject of wonder how they got there, and some naturalists imagined that they were produced by the tissues of the animal body—in fact, by equivocal generation. When, however, it was discovered how elaborate was their construction, and that each animal contained millions of fertile ova, the truth of this theory was disproved, and the naturalist was taught to attribute their production, through the regular laws of generation, to Him who created the highest as well as the lowest order of beings.

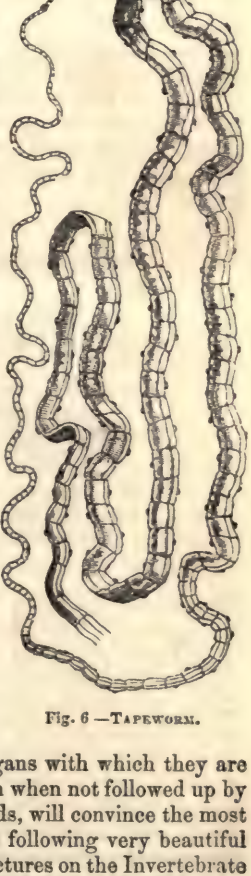


Fig. 6.—Tapeworm.

If we turn to any works in which the Entozoa are figured, it is impossible not to be struck with their great diversity, and with the elaborate delicacy of some of the organs with which they are furnished. Such examination, even when not followed up by that aid which the microscope affords, will convince the most unthinking of the accuracy of the following very beautiful passage from Professor Owen's "Lectures on the Invertebrate Animals:"—"In creatures surrounded by, and having every part of their absorbent surface in contact with, the secreted and vitalised juices of higher animals, one might have antici-

pated little complexity and less variety of organization. Yet the workmanship of the Divine Artificer is sufficiently complicated and marvellous in these outcasts, as they may be termed, of the Animal Kingdom, to exhaust the utmost skill and patience of the anatomist in unravelling their structure, and the greatest acumen and judgment in the physiologist in determining the functions and analogies of the structures so discovered. What also is very remarkable, the gradations of organisation that are traceable in these internal parasites reach extremes as remote, and connect them by links as diversified, as in any of the other groups of Zoophyta, although these play their parts in the open and diversified field of Nature."

Class ZOOPHYTA, or POLYPES.

"Here, too, were living flowers,
Which, like a bud comparted,
Their purple cups contracted;
And now in open blossom spread,
Stretched like green anthers many a seeking head.
And arborets of jointed stone were there,
And plants of fibres, fine as silkworm's thread,
Yea, beautiful as mermaid's golden hair
Upon the waves dispread.
Others that, like the broad banana growing,
Raised their long wrinkled leaves of purple hue,
Like streamers wide o'erflowing."—Southey.

The animals belonging to this class were formerly regarded as vegetables. They were afterwards considered to be partly of an animal and partly of a vegetable nature, which idea is still conveyed in the term *Zoophyte*, a word derived from the Greek, and literally meaning "animal-plant." It is to the labours of John Ellis, a London merchant, who devoted much of his leisure to Natural History, and has shown that such studies are not incompatible with commercial pursuits, that science is indebted for the series of accurate observations which, about a century ago,* established the true position of these singular creatures as members of the animal kingdom.

In the two former classes, the Infusoria and the Entozoa,

*1754, 1755.

no radiated structure was externally apparent. In the present class, it begins to be manifested, not in the form of the body, but in the arrangement of the parts surrounding the mouth. These organs, or *tentacula*, being capable of considerable distension, and being used for the capture of food, probably suggested to the Greek naturalists the application to the animals of the word "*polypi*," the same which they applied to the many-armed Cuttle-fishes, to which externally they bear some resemblance.

The Zoophytes or Polypes, for by both of these terms are they still designated, may be arranged in four great divisions, to each of which in turn our attention may be briefly directed.

Order I.—HYDROIDA.*

In the first family (*Hydraidæ*) of the present order, is found the common fresh-water Hydra (*Fig.* 7), a singular being, whose history is more strange than the strangest fairy tale. Two species are abundant in pools and ditches during warm weather; one (*H. fusca*), furnished with tentacula capable of being distended many times the length of its body; the other (*H. viridis*), with a shorter tentacula, and of a greenish colour. Seen in its contracted state, on the lower side of a leaf or a twig, floating on the water, it appears a little piece of jelly, not larger than the half of a pea. By extending and contracting its body, it can move along, and change its place at pleasure, executing a variety of movements not unlike those of the Caterpillars hereafter mentioned as the "geometric." When it is engaged in taking food, its favourite position seems to be the vertical, which is maintained by a singular proceeding. The tail, or



Fig. 7.—Hydras.

* The term means "Hydra-like."

terminal sucker is exposed to the air until perfectly dry, in which state it repels the water, and thus becomes an instrument for sustaining the body of the little animal in a perpendicular position. In this attitude, the tail being at the surface of the water, the head underneath, it stretches out its tentacula, like so many fishing-lines, for the capture of its prey. These tentacula, there is reason to believe, possess the power of communicating some electric shock, or otherwise stunning the minute inhabitants of the water with which they come in contact (*Fig.* 8).



Fig. 8.—HYDRA.

The most common mode of reproduction in the Hydra is that by gemmation or buds. Little tubercles are observed to arise on the surface of the animal, which ere long assume the appearance of the parent, and then separate; but not unfrequently, even while attached to the body of the parent, the young Hydras throw out buds themselves. In this way, three or four young may be seen at the same time depending from the sides of the mother, and in different stages of growth—

> "Where some are in the bud,
> Some green, and rip'ning some, while others fall."

For our principal knowledge of the habits of the Hydra we are indebted to Trembley, of Geneva, a naturalist who lived in the last century, and devoted much time and attention to the study of this class of animals. His discoveries were published in 1744; and some of the facts he elicited were so astounding that, at first, naturalists refused to give credit to them. He found, for instance, that if a Hydra were divided into two parts, each division became a perfect Hydra, and that the same thing occurred if the creature were cut into forty pieces. Further, he found that if one Hydra were taken, and, by careful management, pulled into the inside of another, the two became incorporated, or formed one body; and that the only

apparent difference, after the change had been effected, was in the increased number of tentacula which the animal exhibited about the mouth. The metamorphoses of which the Hydra was susceptible did not, however, end here. It might be turned inside out, as if it were the finger of a glove, so that what was the skin would become the stomach, and what had been the lining of the stomach would be converted into the skin. Trembley relates the following circumstance. On one occasion two Hydræ—one stronger than the other—had seized a worm. Neither would let go its hold of the prey, and each went on devouring it. At length, however, the stronger Hydra made short work of it with his rival; for he not only swallowed the small worm, but his opponent also. It might be supposed that this tragic occurrence put an end to, at least, one of the combatants, but such was not the fact; for, after an hour or so, the smaller Hydra came forth unhurt. The Hydra is perfectly naked, having no kind of shell nor cover whatever, differing in this respect from the animals of the next family (*Tubulariadæ*).

Two species of Tubularia, taken off the Irish coast, present the appearance of a number of convoluted tubes, each surmounted by a head of scarlet flowers, which the polype has not the power of withdrawing into the tube. It is difficult to convey an idea of the beauty of these sea-born blossoms, when suddenly drawn up by the dredge from a depth of several fathoms, each seeming petal indued with life, and possessing a distinct power of motion.

It has been observed* that, when those animals were kept in the same water for a day or two, the heads dropped off; but, if the water was then changed, new heads appeared, so that a succession of heads might be produced from one stem, with this difference, however, that each new head would have a smaller number of tentacula than the original one. The young are produced by means of germs, and as soon as they are endued with life they are observed to have rudiments of tentacula, but they do not use them for the purpose for which they are employed by the mature animal. It is an object on which a great degree of providential care is bestowed, that the young of marine animals should be widely diffused through

* By Sir J. D. Dalyell. *Vide* Dr. Johnston's "History of British Zoophytes," from which valuable work most of our information has been derived.

the sea, at a distance from the places where the parents are fixed, and where they live and die. Were it not for this wise arrangement, the locality would, in time, cease to supply the conditions requisite for their existence, and the species must perish. The young Tubulariæ use the tentacula as feet, and, by their aid, remove themselves to a fitting distance from the locality of the parent.

The polypes of the third family (*Sertulariadæ**) resemble the Hydra in shape, and are retractile within their cells. Their common habitat or "polypidom"† assumes a tree-like aspect, reminding us, in some species, of miniature ferns and other vegetable productions. These are the corallines, whose feathery tufts decorate the exterior of the common Oyster or Mussel to which they are frequently attached.

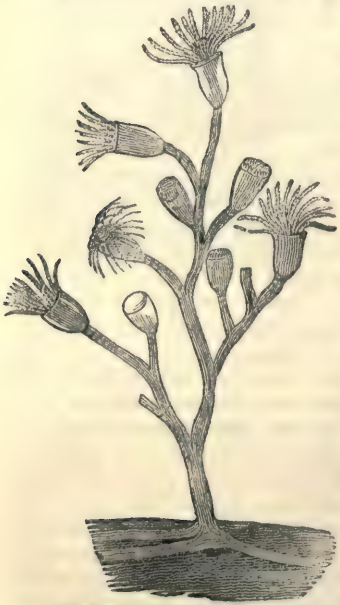


Fig. 9.—Sertularian Zoophyte.

The cells, numerous as they are, are each inhabited by a polype, not as a mere occupant of the cell, and possessed of the power of leaving it at pleasure, but forming, with the cell, the stem, and the root, one living mass. Each polype is connected by a thread with the medullary matter in the centre of each branch, and thus all the parts are united into a compound animal, furnished with a multitude of mouths; for each individual polype contributes, by the food he takes, to the nutriment of all. This structure will be easily understood by the magnified respresentation of one of these animals given in *Fig.* 9. The repetition of any

* From *sertulo*, a little nosegay, wreath, or chaplet of flowers.

† The term is applied to the horny sheath with which the soft body of the polypes is invested.

organ is indicative of a comparatively low grade of organization, and is found only in the lower divisions of the radiate group. An example of this occurs in the numerous stomachs of the polygastrica, and in the ova-producing segments of the body of one of the Entozoa. The multitude of hungry mouths, each collecting food for the entire group, may be regarded as another instance of the same kind of structure. All the cells are not alike. Among them are some of a larger size and different form, which, from their containing the germs or ova, are termed "ovigerous vesicles."

The ova found in these vesicles are covered with hair-like cilia, which have the power of vibrating continually. By means of these, they are able to diffuse themselves over the bottom of the sea, and to swim about for a day or two, until they find a fitting place for their future habitation, and for the establishment of new and populous colonies. When the animal becomes fixed, it first spreads a little, so as to form a secure base; next, cells are observed; then branches teeming with their busy occupants are developed, and the coralline assumes the form characteristic of the species.

Some calculations have been made respecting the number of individual polypes contained in some of these structures. A single plume of a species found upon our shores has been estimated to contain 500. "A specimen of no unusual size has twelve plumes; thus giving 6,000 polypes as the tenantry of a single polypidom! Now, many such specimens, all united too by a common fibre, and all the offshoots of one common parent, are often located on one sea-weed; the site, then, of a population which nor London nor Pekin can rival!* With regard to the growth of these corallines, it has been observed that the lower cells are developed soonest, and after a season drop off altogether. But "there are facts which appear to prove that the life of the individual polypes is even more transitory; that like a blossom they bud and blow, and fall off, or are absorbed, when another sprouts up from the medullary pulp to occupy the very cell of its predecessor, and, in its turn, to give way and be replaced by another."†

Many of these animals possess luminous properties. If some of them, on the frond or broad-spreading leaf of a sea-weed, are subjected to a sudden shock, they give out an

* *Plumularia cristata.* Johnston's Zoophytes, page 144.

† Idem, page 89.

instantaneous flash—a peculiarity alluded to by Crabbe, with his usual minute accuracy:—

> "See, as they float along, th' entangled weeds
> Slowly approach upborne on bladdery beads:
> Wait till they land, and you shall then behold
> The fiery sparks those tangled fronds unfold—
> Myriads of living points; th' unaided eye
> Can but the fire, and not the form, descry."

Order II.—ASTEROIDA.

"We'll dive where the gardens of coral lie darkling,
And plant all the rosiest stems at thy head."—Moore.

The animals of the present order are all marine. They are never found singly, but in a community, forming altogether a polype-mass, variable in form, strengthened in different ways, and having on its surface the cells in which the polypes live, and which open on the surface in a star-like figure, whence the order takes its name (*Fig.* 10).



Fig. 10.—Asteroid Polypes.

To this order belong the family of Pennatulidæ, or Sea-pens. One species, taken in abundance on some parts of the Irish coast, is the *Virgularia mirabilis*, a name which denotes the beauty and singularity of its appearance, for it literally means "wonderful little rod." It is dredged from a muddy bottom, in water a few fathoms deep, and comes up so perfectly clean, that fishermen suppose it stands erect at the bottom, with one extremity fixed in the mud. From the summit to the base of the Virgularia runs a long white, calcareous substance—an axis uniform in thickness throughout. This is the first instance which has as yet come before us of an animal possessing the power of secreting calcareous

matter; a power so remarkably developed in those polypes which are the builders of the coral reefs. If one of the wing-like expansions or "pinnæ" of the Virgularia is injured, the rest shrink as if all were hurt. The creature seems, however, to possess no motion beyond that of the pinnæ; nor, if put into a glass of water, does it change its position.

To the same order belongs the group under which the "Sea-fans" are included. The species most commonly exhibited in museums is the *Gorgonia flabellum*, which has occasionally been thrown ashore on different parts of the coast of England and Scotland. As usually seen, the surface consists of a hard calcareous material; but originally this was covered with an irritable living membrane, in the cells of which the polypes lived. If the Sea-fan were formed throughout of a hard, unyielding substance, it must be broken to pieces by the waves; this danger is obviated by the central axis being composed of concrete albumen, a substance resembling horn, which bends under the force of streams and currents, and is



Fig. 11.—Red Coral.

thus preserved. An American poet has referred to this with equal beauty and accuracy,—

> "There, with a light and easy motion,
> The Fan-coral sweeps through the clear deep sea;
> And the yellow and scarlet tufts of ocean
> Are bending like corn on the upland lea."

In another species (*Isis hippuris*) may be observed an example of the varied but equally effective means by which the same security is attained. Here the stem is composed in part of a horny and in part of a calcareous substance, arranged in alternate joints, and thus uniting strength and flexibility. When recently taken, the stem is covered with one continuous living membrane, in which are the polype-cells. The common Red Coral resembles the Isis, in having a living rind in which the polypes find shelter (*Fig.* 11). Inside of this is found the calcareous substance known as the Red Coral of the Mediterranean. Its growth is slow, and its short, stunted stems require not, for their protection, the beautiful and effectual contrivances exhibited in the Gorgonia and the Isis.

ORDER III.—HELIANTHOIDA.*

> ——— "Seas have—
> As well as earth—vines, roses, nettles, melons,
> Mushrooms, pinks, gilliflowers, and many millions
> Of other plants, more rare, more strange, than these,
> As very fishes, living in the seas."—DU BARTAS.



Fig. 12.—SEA-ANEMONE.

THE name of the present order denotes that the animals it includes bear a resemblance to such flowers as the daisy, the marigold, and others, which the botanist terms "compound" (*Fig.* 12, 14). The most common native species are single,—with a fleshy body, live only in the sea, and have the mouth encircled with tubular tentacula.

The common Sea-anemone, which is generally to be seen in the rock-pools round our shores (*Actinia mesembryanthemum*), may be taken as a

* Like the Sun-flower.

familiar example, and one which will illustrate some of the most striking structural peculiarities of the order.

Viewed when the tide has receded, and the rocks are left dry, the Actinias,* which adhere to them, appear as fleshy, inert, hemispherical bodies, of an olive tinge, or of a liver-coloured vermillion, the tint being variable. But when the advancing tide has again covered them, they are roused to more active life, unfold their tentacula, and present the appearance of expanded flowers, as described by the poet:—

> "Meantime, with fuller reach and stronger swell,
> Wave after wave advanced;
> Each following billow lifted the last foam
> That trembled on the sand with rainbow hues;
> The living flower that, rooted to the rock,
> Late from the thinner element
> Shrunk down within its purple stem to sleep,
> Now feels the water, and again
> Awakening, blossoms out
> All its green anther necks."—SOUTHEY.

Though found attached to the rocks, they are not fixed there permanently, but can shift their place at pleasure. Some species are used as food for man, and, when boiled in sea-water, are said to have both the smell and taste of Lobster. They live upon small aquatic animals of every kind, including crustacea and shell-fish; the hard and indigestible parts being rejected by the mouth, about ten or twelve hours after being swallowed. By the mouth, also, we have seen the young Actinias expelled, as miniature representatives of the parent, and furnished even then with minute tentacula. By attention in changing the water and supplying the necessary food, they can be kept alive for a considerable period, under the observation of the naturalist. Sir John G. Dalyell, of Edinburgh, has had one living under his roof for a period of seventeen years.† They are said to exhibit, under such circumstances, great sensibility of atmospheric changes; so much so, indeed, that a French philosopher‡ asserts that they might be of use as sea-barometers; and he describes, in detail, the manifestations which indicate high winds and agitated waters, fair weather and a calm sea, and their intermediate states. Perhaps, however, no circumstance connected with these animals is more remarkable than their power of bearing mutilation.

* The word literally means "a ray."
† This was in Aug., 1845; in 1848 it was still living and vigorous.
‡ Dicquemare—quoted in Johnston's Zoophytes, page 225.

If the tentacula be destroyed, others are soon after formed. If the animal be cut across into two distinct portions, the upper part continues to take food as usual, though for a time unable to retain it. If severed longitudinally, each half becomes perfect, so that two Actinias are produced; nay, if it be so destroyed that not a fragment is left except a portion of the base, a fresh offspring is soon raised up to fill the place of the parent.

The following characteristic occurrence is related by Dr. Johnston:—"I had once brought to me a specimen of *Actinia gemmacea*, that might have been originally two inches in diameter, and that had somehow contrived to swallow a valve of *Pecten maximus*,* of the size of an ordinary saucer. The shell fixed within the stomach was so placed as to divide it completely into two halves, so that the body, stretched tensely over, had become thin and flattened like a pancake. All communication between the inferior portion of the stomach and the mouth was of course prevented; yet, instead of emaciating and dying of atrophy, the animal had availed itself of what had undoubtedly been a very untoward accident to increase its enjoyments and its chances of double fare. A new mouth, furnished with two rows of numerous tentacula, was opened up on what had been the base, and led to the under-stomach. The individual had, indeed, become a sort of Siamese twin, but with greater intimacy and extent in its unions!"



Fig. 13.—CARYOPHYLLIA.

Belonging to the same order, but to a different family from the Sea-anemones (*Actiniidæ*), are the Coral-building Polypes of tropical seas (*Madrephylliæa*), some of which have been taken in deep water off the British coast (*Fig.* 13). Their structures have been the wonder of the navigator and the theme of the poet; and while Science endeavours to reveal the process by which they are upreared, she but adduces another example that, under the dispensations of Providence, the mightiest of works can be executed by the weakest of agents.

The great extent of some of the coral reefs is very re-

* The common Scallop.

markable. One on the east coast of New Holland is known to be nearly 1000 miles in length, and unbroken for a distance of 350 miles. Some groups in the Pacific are 1100 to 1200 in length, by 350 to 400 in breadth, and these are not formed in an expanse of deep and tranquil waters, but in the midst of an ocean which is ever breaking upon the barrier which the little architects are silently building in the midst of its uproar.

"The ocean," says Mr. Darwin, "throwing its breakers on these outer shores, appears an invincible enemy; yet we see it resisted, and even conquered, by means which seem at first most weak and inefficient. No periods of repose are granted, and the long swell caused by the steady action of the trade-wind never ceases. The breakers exceed in violence those of our temperate regions; and it is impossible to behold them without feeling a conviction that rocks of granite or quartz would ultimately yield and be demolished by such irresistible forces. Yet these low, insignificant coral islets stand, and are victorious; for here another power, as antagonist to the former, takes part in the contest. The organic forces separate the atoms of carbonate of lime one by one from the foaming breakers, and unite them into a symmetrical structure; myriads of architects are at work day and night, month after month, and we see their soft and gelatinous bodies, through the agency of the vital laws, conquering the great mechanical power of the waves of an ocean which neither the art of man nor the inanimate works of Nature could successfully resist."

It was formerly supposed that the coral-building polypes worked in unfathomable depths, and in the course of ages reared their pile to the surface of the water; and it was also conjectured that the oval or circular form of the Lagoon islands might be caused by their being based upon the craters of extinct submarine volcanoes. Both these hypotheses are now abandoned. Recent and widely-extended observations have led to the conclusion that all the phenomena attending the growth and structure of coral reefs may be explained by reference to the combined operation of three causes:—

1st,—That the species of polypes most efficient as coral-builders, work only at limited depths, not exceeding twenty or thirty fathoms.*

* This may seem at variance with the fact, that in the immediate vicinity of some of the Coral islands, the sea is of great, and sometimes

2d,—That in the Pacific and Indian oceans are tracts where a gradual subsidence of the bottom of the sea is going on; and

3d,—That the Polypes work most efficiently at the outer edge of the reef, where the water is the purest and best aërated, and where their food is most abundant.

To enter into further details upon this subject would here be out of place. But this brief notice of the labours of Coral-building Polypes cannot receive a more appropriate close than that which has been furnished by the poet:—

'Millions of millions thus, from age to age,
With simplest skill and toil unwearіable,
No moment and no movement unimproved,
Laid line on line, on terrace terrace spread,
To swell the heightening, brightening, gradual mound,
By marvellous structure climbing tow'rd the day.
Each wrought alone, yet all together wrought.
Unconscious, not unworthy instruments,
By which a hand invisible was rearing
A new creation in the secret deep.
Omnipotence wrought in them, with them, by them;
Hence what Omnipotence alone could do
Worms did. I saw the living pile ascend,
The mausoleum of its architects,
Still dying upwards as their labours closed:
Slime the material, but the slime was turned
To adamant by their petrific touch;
Frail were their frames, ephemeral their lives,
Their masonry imperishable."—MONTGOMERY'S PELICAN ISLAND.

---

of unfathomable depth. But if, according to Mr. Darwin's theory, the polypes began originally to build at moderate depths, and the foundations of their structure were gradually carried downwards by the prolonged subsidence of the bottom of the sea, it is obvious, from his statements, that the ceaseless labours of the polypes are capable, in the lapse of time, of producing all the phenomena described. *Vide* Darwin's interesting work on the Structure and Distribution of Coral Reefs, and an able analysis of his theory in Lyell's Principles of Geol., vol. iii.



Fig. 14.—SEA ANEMONE.

Order IV.—ASCIDIOIDA.

There is among the molluscous or soft-bodied animals, which in popular language are known as "shell-fish," a numerous order in which the animals are covered, not with calcareous shells, but with a soft membranous covering or tunic, and are hence called tunicated mollusca. Among them is a genus bearing the name of "Ascidia," one species of which is everywhere abundant round our coast. To this the Zoophytes of the present order bear such resemblance in structure, that the name "Ascidioida" is employed to denote the likeness.*



Fig. 15.—Plumatella.—*a*, natural size.—*b*, a group, magnified.

These Polypes are not separated, but aggregated; their polypidoms are very variable, both in form and in material; sometimes enamelling with delicate net-work the frond of a seaweed or the exterior of a bivalve shell, at others rising into the aspect of miniature plants, or broad leaf-like expansions. They are furnished with distinct orifices for the reception of food, and for throwing off its undigested remains (*Fig.* 15). Round the mouth is a circle of retractile tentacula covered with

* May, 1854. Recent investigations have shown that this is not a mere resemblance, but a real affinity—that they are formed on the true molluscan type, and should be placed with the *Mollusca Tunicata*.

cilia, from which circumstance the order has been aptly termed "ciliobrachiata." These cilia are "contrived a double debt to pay," for they not only create currents which bring their food within the reach of the Polypes, but they are organs of respiration, and find in the aërated water which surrounds them the means of fulfilling their appointed functions.

To this class of Zoophytes belong the "Sea-mats;" or, to use a more scientific term, the species of the genus "flustra," a word derived from the Saxon, and signifying to weave. Some of these encrust shells or seaweed, others present a foliated appearance of a determinate pattern. They furnish another example of the great abundance of animal life in some of the lower tribes. Though not thicker than common letter-paper, they exhibit, either on one or both sides, successive rows of cells, each of which has been occupied by its own inhabitant. In one species found on the Irish coast, and with cells upon one side only, Dr. Grant calculates "there are more than eighteen cells in a square line, or 1,800 in a square inch of surface, and the branches of an ordinary specimen present about ten square inches of surface; so that a common specimen of *Flustra carbasea* presents more than 18,000 polypi, 396,000 tentacula, and 39,600,000 cilia."

The spectacle presented by one of these polypidoms, when in a saucer containing sea-water, and placed under the microscope, is full of interest. Whether the animals lie in a state of repose, or with the tentacula expanded and in full activity, their aspect and motions are all indicative of happiness. This conviction enhances the pleasure with which we regard them; for truly has the poet said,—

> "The heart is hard in nature
> ——————— that is not pleased
> With sight of animals enjoying life,
> Nor feels their happiness augment his own."—COWPER.

To the scientific zoologist, it is highly instructive to contemplate the affinities which connect these Polypes with creatures so highly organised as the Mollusca. Many similar examples occur in his researches, linking together in close relationship beings which are widely severed in his classification, and showing that "the chain of beings" of which the poet has sung has no real existence in nature.

Class RADIARIA, or RAYED ANIMALS.

———"The firmament
Was thronged with constellations, and the sea
Strewn with their images."—James Montgomery.



Fig. 16.—Star-Fish.

We have now reached the fourth, or highest class of the radiated animals. In these the radiated structure is not confined to the nervous system, or to the arrangement of the parts surrounding the mouth: it extends to the form of the body, and is strikingly manifested in the common Jelly-fish, or in any one of the various Star-fishes (*Fig.* 16) so abundant on our coast. The two examples just mentioned point to an obvious and very natural division of the class. The soft and gelatinous tribes belong to a group of animals whose domain is the wide and open sea; the Star-fish and the Sea-urchin, to a community whose members feed upon garbage and shell-fish, at fathomable depths. The integument or covering of each of these groups of animals is suited to the situation which they are destined to occupy. That of the gelatinous Radiaria is soft and membranous; that of the other is hard, coriaceous, and prickly; thus furnishing a defence against the perils which those species must encounter whose habitat is on coasts exposed to the violence of the ocean. To the former of these two groups, distinguished, because of their stinging powers, by the term *Acalephæ*, a Greek word signifying nettles, our attention may in the first instance be directed.

Order Acalephæ, or Sea-Nettles.

"Awhile to wait upon the firm fair sand,
When all is calm at sea, all still at land;
And these the ocean's produce to explore,
As floating by, or rolling on the shore;
Those living jellies which the flesh inflame,
Fierce as a nettle and from that its name;
Some in huge masses, some that you may bring
In the small compass of a lady's ring;
Figured by hand Divine—there's not a gem
Wrought by man's art to be compared to them;
Soft, brilliant, tender, through the wave they glow,
And make the moonbeam brighter where they flow."—Crabbe.

There is much in the structure of these creatures to excite our surprise. Their frail and gelatinous bodies (*Fig.* 17) seem little else than a mass of vivified sea-water, or some analogous fluid; "For," says Professor Owen,* "let this fluid part of a large Medusa, which may weigh two pounds when recently removed from the sea, drain from the solid parts of the body, and these, when dried, will be represented by a thin film of membrane, not exceeding thirty grains in weight." They baffle the skill of the anatomist by the very simplicity of their structure. Feeble as they appear, fishes

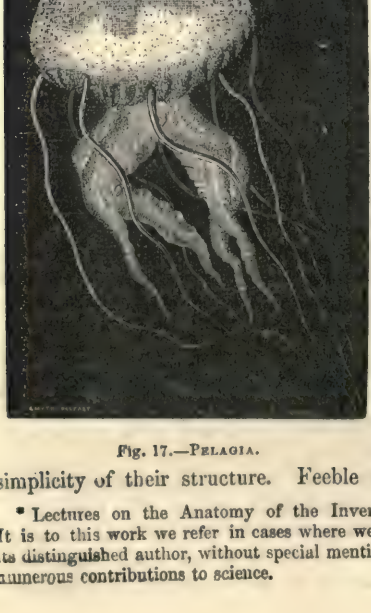


Fig. 17.—Pelagia.

* Lectures on the Anatomy of the Invertebrate Animals, p. 102. It is to this work we refer in cases where we merely give the name of its distinguished author, without special mention of some one of his other numerous contributions to science.

and crustacea are quickly dissolved in their stomachs. The organism of their stinging power is yet but imperfectly understood, and the luminosity which many species possess equally demands investigation. They are found in all seas, and please the eye, both by their glassy transparency and by their brilliant hues.

To the different species of Acalephæ, as to those of other animals, whether inhabitants of the land or of the water, there is allotted a certain range of geographical distribution. They are known within certain boundaries, and beyond these they are rarely found. Now and then, indeed, the winds and the currents bring to our shores marine animals, the inhabitants of warmer climates; and such are, of course, objects of extreme interest to the naturalist.

Some of these may here be mentioned, because they exemplify the great variety of aspect which species belonging to the present division assume, and afford examples of some of its most remarkable families.

In 1838, an animal (*Diphya elongata**) not previously known as an inhabitant of European seas, was captured in Belfast Bay. Its length was about an inch and a half, and its transparency such that the eye could scarcely detect its presence, when the creature was swimming about in a vessel of sea-water. The most remarkable peculiarity in its structure seems to be the facility with which it divides into two parts, each of which continues to exercise powers of voluntary motion, leaving the spectator in doubt whether he is more correct in saying, that it is one animal which easily separates into two, or two animals usually found conjoined in one.

Another inhabitant of the seas of warmer latitudes is the Physalia, or Portuguese Man-of-war, fleets of which are sometimes wrecked upon our southern shores. It exhibits a crest which rises above the surface of the sea, and is enriched with tints of the richest blue and purple.

Sometimes it happens that the sea of our northern shores is enlivened by the mimic fleets of another navigator, the little Velella. On a bluish oval disc it exhibits a snowy, cartilaginous crest, fixed obliquely across, which has been compared to the lateen-sail of the Malay boatmen. Thus propelled, the

* Hyndman in Annals of Nat. Hist. vol. vii. page 164.

living squadrons of this little mariner (*Fig.* 18), have been observed while passing the picturesque headlands of the Giant's Causeway, or the basaltic bulwarks of the harbour of Ballycastle, on the coast of the County Antrim.

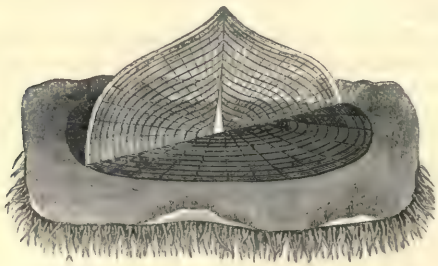


Fig. 18.—Velella.

Upon the southern shores it is, however, of more frequent occurrence. There the specimen was taken of which, by the kindness of Professor Allman, we are enabled to give a figure of the natural size. The original drawing by that gentleman was from a living Velella, respecting which he remarks:—"The individual who sat, or rather *floated*, for his likeness, was one of a fleet of countless multitudes, which, in the Autumn of 1836, was driven upon the coast of the County of Cork. On the subsidence of the gale, which had been blowing strongly from the south-west, the coast for miles round was strewn with the remains of the shipwrecked fleet."

The occurrence of species such as those mentioned is rare; and it is, therefore, desirable to convey some knowledge of the structure and habits of the Acalephæ, not by those which may seldom or perhaps never be observed by the generality of men, but by those which are abundant on our shores, and may be seen and studied by all.

If, during the fine weather of summer or autumn, a gauze towing-net be attached to a boat which is rowed gently along, it is probable that, if the net be examined after a short time, there will be found among its contents some transparent bodies, differing in size, but in general about as large as a boy's marble. Externally they exhibit ridges like those of a

melon, and are in form not unlike an orange or an apple, from which circumstance they take their specific name (*Cydippe pomiformis*, *Fig.* 19).* If gently lifted from the net, and placed in a glass of sea-water, the little animals will begin to move by means of eight bands of vibratile cilia, which extend

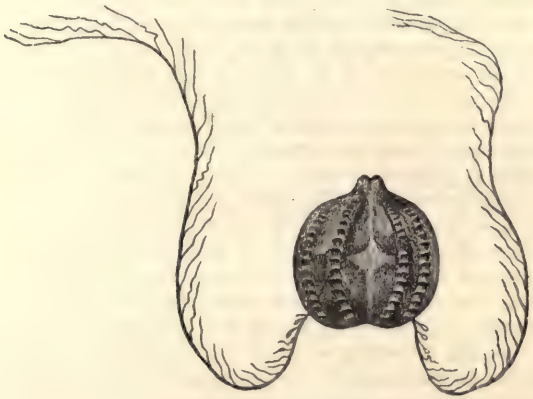


FIG. 19.—CYDIPPE.

from the upper to the lower extremity of the body. From this peculiar mode of locomotion, they are termed *ciliogrades*, and constitute a family which is distinguished by the classic appellation of Beroë, from one of the fabled sea-nymphs.

Specimens of the Cydippe, when recently taken, form most attractive objects, even to the unscientific. Their cilia, which act like so many little paddles on the water, produce a beautiful iridescence, and suggest, as not inapplicable, the language of the poet,—

> ———"Gay creatures of the element,
> That in the colours of the rainbow live."—MILTON.

Their movements are incessant and ever-varying. The little animals can rise or fall at pleasure, executing, as they move up and down, a whole series of gyrations; or without actual

* Transactions of Royal Irish Academy, vol. xix. p. 91.

change of place, can perform with rapidity and ease a rotation which would put to shame the most finished pirouettes of the opera-dancer. During these movements the form of the body is not unfrequently altered, and the lobes of the mouth become more or less distended. These diversified aspects are further increased by the distension or the retraction of two tentacula, furnished on one side with cirri, which are sometimes spread out like delicate hairs, and, at others, are spirally convoluted. By these singular organs the little Beroë can attach itself to the sides or bottom of its glassy prison, and ride, as if at anchor, moored by these singular and delicate cables.

Its food appears to consist of small crustacea,* which may be seen in the transparent stomach for some time after being swallowed. Insensibility to pain, and a continuance of vitality for a long period in mutilated parts, seem to prevail in this, as in some of the other animals already mentioned. When, after a storm, Beroës are taken in a shattered condition, each fragment of their body continues the action of its cilia unimpaired. On one occasion, the author severed one of these fragments into portions so minute, that one piece of skin had but two cilia remaining attached to it; yet the vibration of these organs continued for nearly a couple of days afterwards. On another occasion, a species of Medusa or small jelly-fish, which was furnished with four arms, came in contact with a Cydippe confined in the same glass; the arms immediately closed, and the Cydippe was a prisoner. The diameter of the Medusa was not much greater than that of a sixpence; but it maintained its hold, though we endeavoured to liberate the captive by pushing its conqueror with the stick of a camel-hair pencil. When, at length, it had regained its liberty, the Medusa was found to have cut away a piece fully equal to the one-third of that side it had seized, or a sixth of the entire bulk of the body; yet the Beroë seemed quite unconscious of this mutilation, and did not evince any diminution of its activity or its enjoyment.

It is one of the advantages of natural history pursuits, that they furnish occupation and enjoyment when, from recent indisposition or other causes, either mind or body is unfit for

* We saw them, in May, 1835, feeding on two species then undescribed. One of these was the *Anomalocera Pattersonii*, described and figured by Templeton in the Trans. of the Entomological Society, vol. ii.

laborious exertion. At such a period, in a retired locality on the Antrim coast, the ever-graceful Beroës first attracted our attention, and made the summer day seem too short for the inquiries and researches which they suggested.

A species larger than the Cydippe, and different in form, is also generally diffused round our coast. Its occurrence is more rare, yet it sometimes appears in such abundance, that in Bangor Bay, County Down, we took, on one occasion, one hundred and thirty of them in twenty-five minutes. Its body is more fragile, its movements less active, and it is furnished with four ear-like appendages, which are ever changing in their form. When the water in which it is kept is shaken at night, or in a dark place, splendid coruscations, of a beautiful greenish light, are emitted, especially under the several bands of cilia. On one occasion we placed some specimens of this species (*Bolina Hibernica*)* in a jar on the chimney-piece, and so transparent were the bodies, that the blossoms of some flowers which were also there were distinctly seen through them. It was impossible to look upon these bright-tinted blossoms of earth, and on those colourless, yet not less delicate children of ocean, and not feel that *both* must have enjoyed the guardianship of Him from whom all their loveliness was derived;—that He who had for ages preserved the flowers from perishing by frost, or wind, or rain, had likewise saved the Beroës from destruction, amid the wild tempests of the ocean.

The other great division of the Acalephæ is that to which the jelly-fish, which is so abundantly strewed upon the beach during the summer months, belongs. This group is divided into many genera, comprising about three hundred species. Some are furnished with a central pedunele, and resemble a mushroom with its stalk; others have its place supplied by prehensile arms; some have one simple central mouth, in others both its structure and position are different; in some the margin is furnished with long contractile tentacula, whence the well-known stinging secretion is supplied; in others, this formidable apparatus is altogether wanting. These differences, which are easily observable, enable the naturalist to classify the gelatinous Medusæ, for such is their collective appellation.

Their locomotion is effected by the contraction and expansion

* Trans. R. I. Academy, vol. xix. p. 156.

of the outer margin of the disc, the animal striking the water in the opposite direction to that in which it is moving. The motion is easy and graceful, admitting of progress in any direction. The lower surface of the disc is covered with a delicate net-work of vessels, in which the circulating fluids are exposed to the oxygen contained in the sea-water. Each contraction of the margin, therefore, not only impels the animal in its course, but assists in the process of respiration; and, as the moving and the breathing are thus dependent on the performance of the same act, the term *pulmonigrades** has been applied to these animals; a term no less descriptive than that of "ciliogrades," which, as already mentioned, has been bestowed upon the preceding group.

The Medusæ differ extremely in size. Some are occasionally thrown upon our coast which are as large as a good-sized umbrella. While writing these pages, we have before us, in a jar of sea-water, several which are not larger than peas, and some which scarcely exceed in dimensions the head of a large-sized pin.

Some species are adorned with brilliant colours, and equal in the richness of their hues the brightest of our garden flowers. When, from a small boat, they are beheld rising and falling at pleasure, in a glassy and transparent sea, and occasionally turning over in the apparent exuberance of enjoyment, they are so very attractive as to excite the astonishment of the child, while they furnish matter for the contemplation of the naturalist.



Fig. 20.—Rhizostoma.

Considerable variety prevails in the organs for the reception and assimilation of the food. In the genus Rhizostoma (*Fig.* 20), the arms or peduncles which hang down from the lower surface of the umbrella-shaped disc, are furnished at their extremity with a multitude of pores. By these, the minute animalcules, or the juices of decaying

* *Pulmo*, a lung; and *gradior*, I walk, or advance.

animal substances of larger dimensions, are imbibed, and form the nutriment of the animal. In the genus Cyanea, which is so extremely abundant on our coast, the food is taken by one four-lipped mouth, and is of a coarser kind, consisting principally of crustacea and small fishes. A provision for throwing off the undigested portions is therefore required, and we accordingly find that no less than eight canals lead from the centre of the disc to the outer margin, and are appropriated exclusively to this use; an apparatus which, in the other genus, was not wanted, and which, accordingly, had no existence.

To the minute and laborious researches of modern naturalists, we are indebted for a knowledge of the fact, that the sexes in these animals are separate, and that the ova, or eggs, undergo a singular and highly interesting series of transformations before assuming the likeness of the parent.

The species of Medusa most abundant on our coasts during the early part of the summer (*Cyanea aurita*) is well known by the four conspicuous lunar or heart-shaped figures which it exhibits. These are of a pinkish or purplish colour, and are, in fact, the ovaries. Four pouches are observed on the lower surface of the body. To these the young, at a certain period, are transferred from the ovaries, and undergo a species of development analogous to that of the young quadrupeds of Australia in the marsupial pouch of the mother. After changes in their size and colour, they exhibit a change of form, become clothed with vibratile cilia, and, leaving the maternal pouch, swim freely about, the larger extremity being always in advance (*Fig.* 21). The little creature soon at-

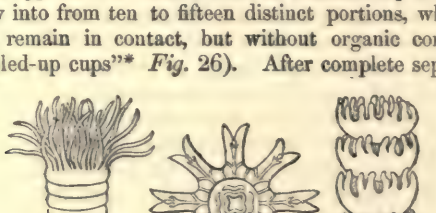


21. 22. 23. 24.

DEVELOPMENT OF THE MEDUSÆ.

taches itself to some fixed object (*Fig.* 22), and four arms appear, surrounding a central mouth (*Fig.* 23). The arms lengthen, four additional ones are developed, all are highly contractile, covered with cilia, and actively employed in the capture

of food. The number of these arms increases until it reaches twenty-four or thirty; and the body, originally about the size of a grain of sand, becomes a line, or the twelfth part of an inch in length. The animal, in its free state, swims about in the manner of the Polygastric animalcules; in its present condition, it presents an analogy to the habits of the Rotifera. During the winter months, it remains in security, "where the waves have no strife," and even throws out germs, or buds, which in time become perfect Medusæ (*Fig.* 24). But, with the approach of spring, the body becomes marked with transverse lines (*Fig.* 25), which gradually assume a wrinkled or furrowed appearance. These furrows become deeper, dividing the body into from ten to fifteen distinct portions, which, for a time, remain in contact, but without organic connexion, "like piled-up cups"* *Fig.* 26). After complete separation,



25. 27. 26.

DEVELOPMENT OF THE MEDUSÆ.

each part swims freely about, presenting an appearance so unique, that the young, in this state, has been figured and described as belonging to a new genus (*Fig.* 27).

The last change observable is its putting on the appearance of the perfect animal, and under the influence of the sun, the waves, and the currents, becoming a mature Medusa. "We thus see," says Professor Owen, "that a Medusa may actually be generated three successive times, and by as many distinct modes of generation—by fertile ova, by gemmation, and by spontaneous fission—before attaining its mature condition."

Our admiration of the various functions performed by the

* Such is the expression employed by Steenstrup in his Memoir "on the Alternation of Generations;" published by the Ray Society, 1845 The facts and illustrations we give on the authority of Steenstrup, Sars and other distinguished naturalists.

Acalephæ is much increased when we reflect upon the extremely small quantity of solid matter which enters into their composition. This fact admits of easy illustration, both in the Beroës and in the Medusæ.

On one occasion we took a dead Cydippe, and placing it on a piece of glass, exposed it to the sun. As the moisture evaporated, the different parts appeared as if confusedly painted on the glass, and when it was become perfectly dry, a touch removed the only vestiges of what had been so lately a graceful and animated being.

With regard to the Medusæ, we may mention an anecdote which we learned from an eminent zoologist, now a professor in one of the English universities. He had, a few years ago, been delivering some zoological lectures in a seaport town in Scotland, in the course of which he had adverted to some of the most remarkable points in the economy of the Acalephæ. After the lecture, a farmer who had been present came forward, and inquired if he had understood him correctly, as having stated that the Medusæ contained so little of solid material, that they might be regarded as little else than a mass of animated sea-water? On being answered in the affirmative, he remarked that it would have saved him many a pound had he known that sooner, for he had been in the habit of employing his men and horses in carting away large quantities of jelly-fish from the shore, and using them as manure on his farm, and he now believed they could have been of little more real use than an equal weight of sea-water. Assuming that so much as one ton weight of Medusæ recently thrown on the beach had been carted away in one load, it will be found that, according to the experiments of Professor Owen already mentioned,* the entire quantity of solid material would be only about four pounds of avoirdupois weight, an amount of solid material which, if compressed, the farmer might, with ease, have carried home in one of his coat pockets!

Perhaps there is no circumstance connected with this class of animals more attractive or more remarkable than the power they possess of emitting a beautiful phosphorescent light; and, in some of the larger Medusæ, this is of such intensity, that they have been compared to balls of fire suspended in the water.

* *Vide ante*, page 30

To those who delight in the contemplation of such phenomena, it affords high gratification to observe from a boat, on a calm night, the effulgence which these creatures shed over the depths below. We have always, at such times, been reminded of the wild and beautiful lines of Coleridge:—

"Beyond the shadow of the ship
I watched the water-snakes;
They moved in tracks of shining white,
And when they reared, the elfish light
Fell off in hoary flakes.

"Within the shadow of the ship
I watched their rich attire:
Blue, glossy green, and velvet black;
They coiled and swam, and every track
Was a flash of golden fire.

"O happy living things! no tongue
Their beauty might declare:
A spring of love gushed from my heart,
And I blessed them unaware."

Professor Rymer Jones, in speaking of the luminosity of the ocean, which is principally owing to the Acalephæ, remarks:—"We have more than once witnessed this phenomenon in the Mediterranean, and the contemplation of it is well calculated to impress the mind with a consciousness of the profusion of living beings existing around us. The light is not constant, but only emitted when agitation of any kind disturbs the microscopic Medusæ which crowd the surface of the ocean; a passing breeze, as it sweeps over the tranquil bosom of the sea, will call from the waves a flash of brilliancy which may be traced for miles; the wake of a ship is marked by a long track of splendour; the oars of your boat are raised dripping with living diamonds; and if a little of the water be taken up in the palm of the hand, and slightly agitated, luminous points are perceptibly diffused through it, which emanate from innumerable little Acalephæ, scarcely perceptible without the assistance of a microscope. All, however, are not equally minute; the Beroës, in which the cilia would seem to be most vividly phosphorescent, are of considerable size; the *Cestum Veneris*, as it glides rapidly along, has the appearance of an undulating ribbon of flame several feet in length; and many of the larger Pulmonigrade forms shine with such dazzling brightness, that they have been described

by navigators as resembling 'white-hot shot,' visible at some depth beneath the surface." *

The phenomenon is not, however, confined to warmer latitudes. Sir Walter Scott, in his "Lord of the Isles," has described it in our own seas:—

"Awaked before the rushing prow,
The mimic fires of ocean glow,
Those lightnings of the wave;
Wild sparkles crest the broken tides,
And, flashing round the vessel's sides,
With elfish lustre lave,
While, far behind, their livid light
To the dark billows of the night
A gloomy splendour gave."

The power of emitting light is possessed by several species of marine animals, among the Polypes, Annelids, Crustacea, and Mollusca. It was formerly a question, to what cause the luminosity of the sea was to be attributed? By some philosophers it was supposed to be owing to the decay of animal substances which it contained; while others conjectured that it arose from a kind of electricity peculiar to itself. These hypotheses are now abandoned, and it is generally admitted, that the phosphorescence of the sea is owing to that of its living inhabitants, more especially of those which belong to the present order; and it has been found, that the species of Medusæ most instrumental in producing the luminosity of the ocean, are those which are the most minute.

Perhaps no writer has succeeded in giving a clearer idea of the myriads of small Medusæ with which great tracts of the sea are peopled, than Scoresby. On examining a bucket of the olive-green water of the Greenland sea, he found its peculiar colour was owing to the multitude of minute Medusæ which it contained. "They were about the one-fourth of an inch asunder. In this proportion, a cubic inch of water must contain 64; a cubic foot, 110,592; a cubic fathom, 23,887,872; and a cubical mile, 23,888,000,000,000,000!" "Provided the depth to which they extend be but 250 fathoms, the above immense number of one species may occur in a space of two miles square. It may give a better conception of the amount of Medusæ in this extent if we calculate the

* Outline of the Animal Kingdom, page 77.

length of time that would be requisite, with a certain number of persons, for counting this number. Allowing that one person could count a million in seven days, which is barely possible, it would have required that 80,000 persons could have started at the creation of the world, to complete the enumeration at the present time!"

"What a stupendous idea this fact gives of the immensity of creation, and of the bounty of Divine Providence in furnishing such a profusion of life, in a region so remote from the habitations of men! But if the number of animals in a space of two miles square be so great, what must be the amount requisite for the discolouration of the sea, through the extent of perhaps twenty or thirty thousand square miles?" * Even if the learned author, from whom this extract is taken, should prove to be incorrect in his supposition as to the depth to which the Medusæ extend, the spirit of his argument would remain unshaken. His observations prove, that they people, in countless multitudes, tracts of ocean which, without them, would be uninhabited, thus filling its vast expanse with life, and with the enjoyment by which life is accompanied; while, at the same time, they furnish an inexhaustible supply of food to whales and other cetacea, and many of the less bulky inhabitants of the deep. Thus, minute though they are, they indirectly contribute to the welfare of man, and exercise an influence on his social relations.

CLASS RADIARIA—CONTINUED.

Order Echinodermata, or Star-Fishes.

"As there are stars in the sky, so there are stars in the sea."—Link.

The second great division of the rayed animals comprises all those which have a hard coriaceous integument (*Fig.* 28), covered, in some species, with prickles like those of the hedgehog. The word "*Echinus*" means hedgehog; the word "*derma*," a coat or covering. Hence the compound word "*Echinodermata*" is an appropriate and characteristic

* Scoresby's Arctic Regions, vol. i. page 179.

term, as applied to all those creatures whose integument is coriaceous or prickly.

The Echinodermata exhibit, in many respects, an entire contrast to the Acalephæ. That of their covering is obvious to the most cursory observer; that of their internal structure is not less remarkable. The anatomist is baffled by the seeming simplicity and uniformity of texture in the gelatinous



Fig. 28.—Star-fish.

Radiaries; in the harder, or spine-clad species, the extreme complexity and diversity of their constituent parts is found to be no less perplexing.*

All the animals of this class are marine, and in their adult state move freely about. The sexes are distinct, and the young are produced from ova, which, in a certain stage of their development, become covered with minute cilia. They then come forth as ciliated gemmules, are diffused over the bottom of the sea, and undergo a series of transformations analagous to those described in the Medusæ. The observations of a Norwegian naturalist† have made us aware of an interest-

* Owen, page 112.

† Sars, *vide* Annals Nat. Hist. Oct. 1844, page 233, and plate III.

ing fact respecting the maternal solicitude evinced in a species of Star-fish, found upon our own shores (*Cribella oculata*, *Fig.* 29). The mother, by bending the arms and the lower surface of the body, forms a receptacle which, in its uses, may be compared to that of the marsupial animals, or to the pouches of the Medusæ. Here the ova are hatched; and for the space of eleven successive days, during which this process is going on, the female Star-fish has remained in the same recurved and contracted state, and without the possibility of taking nourishment during that period. We do not, at present, know any other example of an animal voluntarily forming a receptacle for the development of its young exterior to its own body, and enduring the privations consequent upon such a procedure.



Fig. 29.—Eyed Cribella.

In this group, we find animals of extremely dissimilar appearance associated together. One species is attached for a certain period to a stem, and resembles a Polype with its waving and sensitive arms. In the common Star-fish, or "five-fingers," we have the arms radiating from a common centre. In the Sea-urchins, there are no arms, and the form of the body is globular, and, passing over some intermediate gradations of figure, we reach creatures which, in external aspect, resemble worms, and have even been classed as such. At one extremity of the range, the Echinodermata remind us of Polypes—creatures of inferior organization; at the other extremity, they approach the annulose* animals, whose structure is of a higher grade. Those occupying the centre of the group may be regarded, therefore, as the types or representatives of the class.

In Professor Forbes' "History of the British Star-fishes,"† the entire class is divided into six families. The first of these includes those animals which, in a fossil state, are known as

* A term derived from *annulus*, a ring, and applied to animals which like the Earth-worm are composed of a succession of rings.

† John Van Voorst: London. This is one of that beautiful series of Natural History works, for which we are indebted to that enterprising publisher. From it we have copied figures 31 and 32; the latter reduced.

"stone-lilies" (*Fig.* 30), and the term (*Crinoideæ*) applied to the family is one which simply means "lily-like." The abundance of these animals in former ages, and their present scarcity, have suggested the following paragraph, which we extract from the work just referred to. "One of the most remarkable phenomena displayed to us by the researches of the geologist, is the evidence of the existence, in primeval times, of animals and plants, the analogues of which are now rare or wanting on our lands and in our seas. Among those tribes which have become all but extinct, but which once presented numerous generic modifications of form and structure, the order of Crinoid Star-fishes is most prominent. Now scarcely a dozen kinds of these beautiful animals live in the seas of our globe, and individuals of these kinds are comparatively rarely to be met with: formerly they were among the most numerous of the ocean's inhabitants;—so numerous that the remains of their skeletons constitute great tracts of the dry land as it now appears. For miles and miles we may walk over the stony fragments of the *Crinoideæ;* fragments which were once built up in animated forms, encased in living flesh, and obeying the will of creatures among the loveliest of the inhabitants of the ocean. Even in their present disjointed and petrified state, they excite the admiration, not only of the naturalist, but of the common gazer; and the name of stone-lily, popularly applied to them, indicates a popular appreciation of their beauty."



Fig. 30.—Encrinite.

We have already seen, among the Zoophytes, instances of the secretion of calcareous matter within a living body. If we suppose a Polype on a long-jointed stalk, extending five pair of arms, composed of a vast number of pieces, all uniformly shaped and jointed together, we shall have some idea of what these animals were in their living state. The detached

vertebræ are well described by the common English name of "wheel-stones." "The perforations in the centre of these joints, affording a facility for stringing them as beads, has caused them, in ancient times, to be used as rosaries.* In the northern parts of England, they still retain the appellation of St. Cuthbert's beads." Sir Walter Scott has, with his usual felicity, referred to the circumstance in his poem of Marmion:—

> "But fain St. Hilda's nuns would learn
> If, on a rock by Lindisfarn,
> St. Cuthbert sits, and toils to frame
> The sea-born beads that bear his name."—CANTO II.

The race of Crinoid Star-fishes was believed to be altogether extinct in European seas, when, in 1823, Mr. J. V. Thompson announced the discovery, in the Cove of Cork, of a diminutive species measuring only three-quarters of an inch in length. In 1836, the same gentleman proclaimed that this was the young state of the Star-fish known as the Rosy-feather-star (*Comatula rosacea, Fig.* 31). The actual change of the animal, from its fixed and pedunculated state into its free condition, had not actually been seen by this intelligent observer. But at length the matter was placed beyond any possibility of doubt.

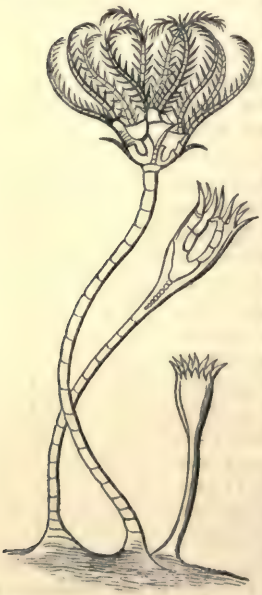


Fig. 31.—POLYPE STATE OF THE FEATHER-STAR (MAGNIFIED).

"When dredging," says Professor Forbes, "in Dublin Bay, in August, 1840, with my friends Mr. R. Ball and Mr. W. Thompson, we found numbers of the Phytocrinus or polype state of the Feather-star, more advanced than they had ever been seen before; so advanced that we saw the creature drop from its stem, and swim about a true

* Buckland's Bridgewater Treatise, vol. i. page 424.

Comatula; nor could we find any difference between it and the perfect animal, when examining it under the microscope.*

The species which formed the subject of these interesting observations has five pair of beautifully pinnated arms, and is of a deep rose colour, dotted over with minute brown spots, which are regarded as the ovaries. It is dredged up on many parts of the Irish coast, and is occasionally found upon the strand. The first specimen we ever possessed was taken on the beach about six miles from Belfast, and was brought to that town alive. Anxious to secure so attractive a specimen for the cabinet, we placed it in a shallow vessel of fresh water, and found, to our surprise, that it emitted a fluid, which imparted to the water a roseate tinge.

The second family consists of those Star-fishes which have a roundish central body, furnished with five long arms, not unlike the tails of Serpents (*Fig.* 32); and as the word *ophiura* means a Serpent's tail, the term *Ophiuridæ* has been adopted as the family apellation. These arms are not furnished with suckers, like those of the next division, nor do they contain any prolongation of the digestive organs. They are merely arms external to the body, and easily separated from it at the pleasure of the animal; from which circumstance the English name of "Brittle-stars" has been bestowed upon the tribe. Its members differ very much in size and appearance. Some of them measure as much as sixteen inches in diameter; others are so small, that a score or two of them might be displayed on an ordinary visiting-card. Those who have looked upon such objects only in the dried and rigid aspect they present in our museums, can form no idea of the flexibility, variety, and beauty which they present in the living state. We have, on

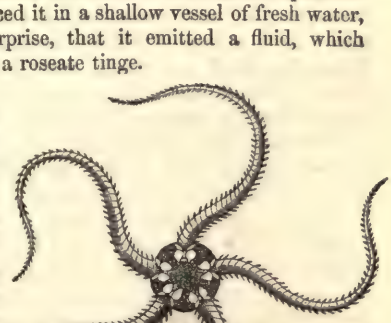


Fig. 32.—Common Sand-star.*

* *Ophiura texturata.* Forbes, p. 22.

many occasions, seen a dredge come up half filled with a spine-covered species (*Ophiura rosula*) everywhere abundant round the coast, and can bear testimony to the accuracy of Professor Forbes' description:—"Of all our native Brittle-stars, this is the most common and the most variable. It is also one of the handsomest, presenting every variety of variegation, and the most splendid displays of vivid hues arranged in beautiful patterns. Not often do we find two specimens coloured alike. It varies also in the length of the ray-spines, the spinousness of the disc, and the relative proportions of rays and disc; and in some places it grows to a much greater size than in others. It is the most brittle of all Brittle-stars, separating itself into pieces with wonderful quickness and ease. Touch it, and it flings away an arm; hold it, and in a moment not an arm remains attached to the body."

The word *aster* means a star, and the term *Asteriadæ* is applied to the third family; that to which the true Star-fishes, or those which are typical of the class, belong. If we take from our cabinets a dried specimen of the common Cross-fish, or "Five-fingers," we find the mouth on the lower surface of the central disc, and five rays, with deep grooves throughout their entire length. Each groove contains a multitude of small orifices, through each of which, when alive, the animal could protrude a tubular organ, capable of adhering to the surface of any body to which it was applied. By such means, its prey can with ease be overcome, dragged into the oral orifice in the centre of the rays, and devoured.

But these suckers, which render the Cross-fish so formidable an assailant, are not only organs of prehension—they are also organs of locomotion. To appreciate them aright, they must be seen in action; for words alone will not convey an adequate idea of the singularity and beauty of their mechanism. On this subject, we prefer the words of Professor Rymer Jones to any which we ourselves could employ*:—"Let any of our readers, when opportunity offers, pick up from the beach one of these animals, the common Star-fish of our coast, which, as it lies upon the sand, left by the retiring waves, appears so incapable of movement, so utterly helpless and inanimate; let him place it in a large glass jar, filled with its native element, and watch the admirable spectacle which it then

* Outline of the Animal Kingdom, p. 141.

presents; slowly he perceives its rays to expand to its full stretch, hundreds of feet are gradually protruded through the ambulacral* apertures, and each apparently possessed of independent action, fixes itself to the sides of the vessel as the animal begins to march. The numerous suckers are soon all employed, fixing and detaching themselves alternately, some remaining firmly adherent, while others change their position; and thus, by an equable, gliding movement, the Star-fish climbs the sides of the glass in which it is confined, or the perpendicular surface of the sub-marine rock."

It has been remarked, that the Star-fishes are furnished with five rays; and although individuals are met with which have four or six rays, the five-rayed predominate so much, that, among the problems proposed by Sir Thomas Browne, is one, "Why, among Sea-stars, Nature chiefly delighteth in five points?" Throughout all the animals of this class, five is the governing number, regulating even the plates of which the "shell" of the Sea-urchin is composed. In the Medusæ, the governing number is four; and each Jelly-fish, with but few exceptions, exhibits, in the arrangement of its parts, the number four, or some multiple of that number.†

Although the rays of the Crossfish, or "Five-fingers," are not mere arms, but true prolongations of the body, and, in many species, have an eye well defended by spines at the extremity, they are frequently broken off, and in such cases are reproduced. The oyster fishermen believe that it loses its rays in attempting to seize the oyster at a time when the shell is incautiously left open. That it is injurious to oyster-beds may be true, for it is known to feed upon different kinds of Mollusca; but it would appear to overpower its prey, by applying some poisonous secretion, and pouting out the lobes of the stomach, so as to convert them into a kind of proboscis, and thus suck the Molluscs from their shells.

A species which Mr. Ball has taken in great abundance about Youghal seems to emulate the Brittle-stars in the facility with which it can fling off its rays. It is appropriately named *Luidia fragilissima*, and has been so graphically delineated by Professor Ed. Forbes, that it would be doing

* A term derived from the Latin word *ambulacra*, from a fancied resemblance which the rows of apertures bear to the walks, alleys, or avenues of some of our old mansions.

† Forbes, Intr. page 15.

injustice to the reader not to present him with the portrait which that gentleman has furnished:—"It is the wonderful power which the *Luidia* possesses, not merely of casting away its arms entire, but of breaking them voluntarily into little pieces with great rapidity, which approximates it to the *Ophiuræ*. This faculty renders the preservation of a perfect specimen a very difficult matter. The first time I ever took one of these creatures I succeeded in getting it into the boat entire. Never having seen one before, and quite unconscious of its suicidal powers, I spread it out on a rowing bench, the better to admire its form and colours. On attempting to remove it for preservation, to my horror and disappointment I found only an assemblage of rejected members. My conservative endeavours were all neutralized by its destructive exertions, and it is now badly represented in my cabinet by an armless disc and a discless arm. Next time I went to dredge on the same spot, determined not to be cheated out of a specimen in such a way a second time, I brought with me a bucket of cold fresh water, to which article Star-fishes have a great antipathy. As I expected, a *Luidia* came up in the dredge, a most gorgeous specimen. As it does not generally break up before it is raised above the surface of the sea, cautiously and anxiously I sank my bucket to a level with the dredge's mouth, and proceeded, in the most gentle manner, to introduce *Luidia* to the purer element. Whether the cold air was too much for him, or the sight of the bucket too terrific, I know not; but in a moment he proceeded to dissolve his corporation, and at every mesh of the dredge his fragments were seen escaping. In despair I grasped at the largest, and brought up the extremity of an arm with its terminating eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision."

The members of the fourth family, that of the Sea-urchins (*Fig.* 33) are furnished with spines, and, from the resemblance in this respect to the Hedgehog (*echinus*), the family bears the name *Echinidæ*. Here the arms have disappeared, and the form has become more or less rounded, according to the species. The spines do not grow from the "shell," or, to use a more correct term, the integument, as thorns do on the branches of the common hawthorn. They are attached to tubercles, and move upon them in the manner of so many ball-and-socket joints. The Sea-urchins are also furnished

with retractile suckers, similar to those described in the Star-fishes; and, by the joint action of their spines and suckers,

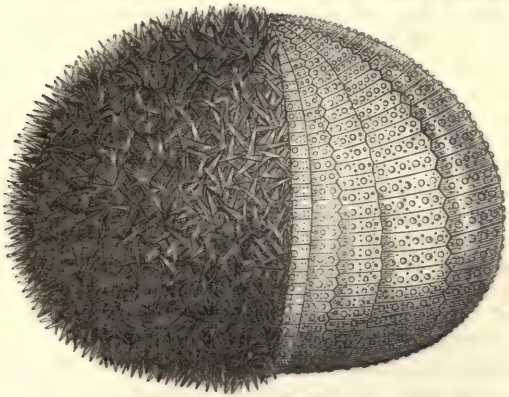


Fig. 33.—Sea-urchin (exterior).*

they can move in any direction they please, or can moor themselves to the surface of sub-marine rocks.

The calcareous covering of the Sea-urchin exhibits a singular and beautiful contrivance for the progressive growth of the animal. It is not one piece, as the word "shell," so commonly applied to it, would lead us to suppose. It is formed of a multitude of pentagonal pieces, accurately fitted together, some rows of them bearing the tubercles to which the spines are attached, and others pierced with hundreds of minute orifices, through which the tubular suckers are protruded. A living membrane, analogous to that found in some of the Polypes, covers the entire surface, and dips down between the several plates. It has the power of depositing a calcareous secretion, which, being added to the edges of the plates, augments all in an equal ratio; and thus, whatever may be the size of the Sea-urchin, the relative proportion of the several parts is uniformly maintained.

It is impossible to contemplate the admirable mechanism of the spines and suckers, and the elaborate structure of the shell, without at once feeling the conviction that in them we behold a portion of "the works of the Lord, and His wonders

* Fig. 33.—The spines have been removed from the left side for the purpose of exhibiting the arrangement of the pieces composing the "shell" underneath.

in the deep." And this feeling increases with the increased minuteness of our examination. "In a moderate-sized Urchin I reckoned," says Mr. Forbes, "sixty-two rows of pores in each of the ten avenues. Now, as there are three pairs of pores in each row, their number multiplied by six, and again by ten, would give the great number of 3,720 pores; but, as each sucker occupies a pair of pores, the number of suckers would be half that amount, or 1,860. The structure in the Egg-urchin is not less complicated in other parts. There are above 300 plates of one kind, and nearly as many of another, all dovetailing together with the greatest nicety and regularity, bearing on their surfaces above 4,000 spines, each spine perfect in itself, and of a complicated structure, and having a free movement on its socket. Truly the skill of the Great Architect of Nature is not less displayed in the construction of a Sea-urchin than in the building up of a world!"

Respiration is secured in these animals by the free admission of sea-water through the pores in the external covering, and by its propulsion, by means of cilia, over every portion of the body. A large portion of the interior of the shell is, at certain times, occupied by vessels filled with the ova, which, in the Mediterranean and elsewhere, are much prized as an article of food; but, at other times, the ordinary observer finds in the interior only a tube wound twice round the circumference, and containing the stomach and intestine (*Fig.* 34). In every step we make towards a knowledge of the structure and habits of these animals, we experience a feeling of surprise and pleasure at the peculiarities they exhibit. Thus, on one occasion, we had cut horizontally into two nearly equal parts a large Sea-urchin, for the purpose of examining the intestines and ovaries. These being removed, the shell was thrown on the deck of our little vessel, as being no longer of any service. It chanced, however, that we afterwards picked up the parts and placed them in a shallow vessel of sea-water. To our surprise, the suckers were soon extended, and the animal walked about, apparently as unconcerned as if the loss of intestine and ovaries had been an every-day occurrence.

At one extremity of the alimentary canal is a singular apparatus, which performs the functions of teeth and jaws, and which, in its detached state, is known as "the lanthorn of Aristotle." Any teeth, fixed in sockets as ours are, would speedily be worn away by their action on the shell-fish, &c.;

upon which the Sea-urchins feed. They are, therefore, constituted with a continual growth, as in the case of the gnawing animals, and the points have all the hardness of enamel. Five jaws, admirably adapted to act as grinders, are furnished with bony pieces, ligaments, and muscles, so contrived and arranged as to draw from Professor Rymer Jones the remark, "these jaws, from their great complexity and unique structure,

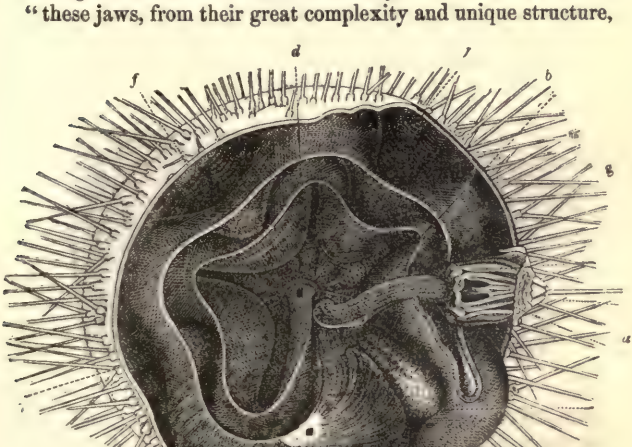


Fig. 34.—Sea-urchin (interior).

form perhaps the most admirable masticating apparatus met with in the whole animal kingdom" (*Fig.* 34).

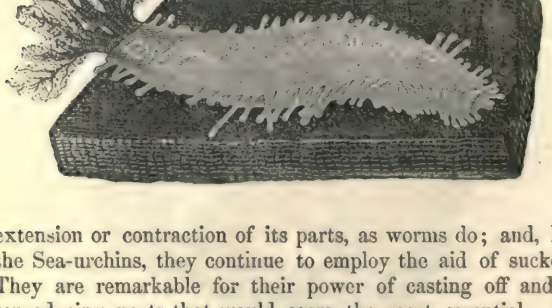
The Purple Sea-urchin (*Echinus lividus*) is remarkable for its habit of boring, principally into limestone rocks, and living in the excavation thus formed. It is gregarious, and was found in abundance by Mr. Ball and Mr. Thompson, when visiting the south Isles of Arran, in 1834. "It is always stationary; the hole in which it is found being cup-like, yet fitting so as not to impede the spines. Every one lived in a hole fitted to its own size—the little ones in little holes, and the large

Fig. 34.—Anatomy of Sea-urchin (*Echinus*).

a, Mouth, with the teeth and jaws.—*b*, Œsophagus.—*c*, Stomach, or first portion of the intestine.—*d*, Intestine.—*e*, Ovary.—*f*, Ambulacral vesicles.—*g*, Shell with spines.

ones in large holes; and their purple spines and regular forms presented a most beautiful appearance studding the bottoms of the gray limestone rock-pools."

The individuals of the fifth family (*Holothuridæ*) are not likely to attract the notice of the casual observer, and are of comparatively rare occurrence even to the naturalist. The English term, Sea-cucumbers (*Fig.* 35), gives some idea of their general form. In them the spines have disappeared; but, as the covering of the body is soft, they can move by the



extension or contraction of its parts, as worms do; and, like the Sea-urchins, they continue to employ the aid of suckers. They are remarkable for their power of casting off and of reproducing parts that would seem the most essential. Sir J. G. Dalyell* has known them to lose "the tentacula, with the cylinder (dental apparatus), mouth, œsophagus, lower intestinal parts, and the ovarium, separating from within, and leaving the body an empty sac behind. Yet in three or four months, all the lost parts are regenerated."

Mr. Forbes states,—"It is this animal which the Malays of the Oriental Isles seek so diligently for the supply of the China market, where it obtains a good price when well preserved. It is employed by the Chinese in the preparation of nutritious soups, in common with an esculent sea-weed, Sharks' fins, edible birds' nests, and other materials, affording much jelly. Jaeger says the intestines are extracted, the animal then boiled in sea-water, and dried in smoke."

A species found off the coast of Cornwall, and first described

* Paper read at Glasgow Meeting (1840) of British Association.

by Mr. Peach at the York Meeting of the British Association, in 1844, bears the singular name of "the nigger," from its dark colour, and the "cotton-spinner," from its long white threads.*

The members of the sixth family (*Sipunculidæ*) in external appearance resemble worms; but, from an examination of their internal structure, it is ascertained that they must, in reality, be classed among the Star-fishes. They are not furnished with suckers, nor do they exhibit any quinary arrangement of parts; and their movements are so entirely those of worms, that they are, with great propriety, termed "*Vermigrade Echinodermata.*" Some are found under stones, some burrow in sand, and some select as their mansion an empty univalve shell; their habits, however, are as yet imperfectly known.

We have now completed our proposed sketch of the radiate animals, commencing with the microscopic animalcules, and advancing to those in which the radiated structure attains its highest perfection. To all we may apply the remark with which Professor Forbes concludes the excellent work from which we have so largely quoted.

"Among the British Echinodermata we have seen some of the most extraordinary forms in the animal kingdom; some of the most wonderful structures and of the strangest habits. Much yet remains to be done towards their elucidation, and the investigation of them, both structurally and formally, presents a wide field of inquiry to the student of nature, as yet but imperfectly explored. The great naturalist of Denmark,

* Mr. C. W. Peach is one of those lovers of natural history whose ardour in the pursuit surmounts all difficulties. At the time we first made his acquaintance, in 1841, he held a very subordinate situation in the coast guard, and had a numerous family dependent on his scanty pay. He was the schoolmaster of his own children, and the superintendent of the Sunday school of the village of Goran Haven, Cornwall, where he then resided. Yet, notwithstanding his ceaseless avocations, and the laborious night and day duties of his situation, natural history was never neglected; and in his solitary rides along the beach, his eye, trained to observe, was ever on the alert. Thus he collected the materials for several communications on Geology and Zoology, made by him at successive meetings of the British Association. We are happy to add that some of the influential members of that body, appreciating his exertions, represented them to government in such colours, that he was appointed to a situation of comparative ease and comfort in the custom-house at Fowey. He has since been promoted, and is now at Wick, Caithness-shire.

Müller, long ago said that we need not resort to distant regions and foreign climes for rare or wonderful creatures;—that the fields, the woods, the streams, and the seas of our native lands, abounded in wondrous evidences of God's power and wisdom. The investigation of our native animals must ever be a chief source of sound zoological knowledge; for it is there only we can watch, under favourable circumstances, for the observation of their development, their habits, and their characters. The naturalist whose acquaintance is confined to preserved specimens in a cabinet, can form but a vague idea of the glorious variety of nature, of the wisdom displayed in the building up of the atoms of matter to be the houses of life and intellect; and, unless we study the creatures living around us, how can we gain that delightful knowledge? The passing note of an animal observed during travel is an addition to science not to be scorned; the briefly characterizing of a new species from a preserved specimen, if done with judgment, is of importance; but the real progress of natural history must ever depend on the detailed examination of the beings gathered around us by the laws of geographical distribution, living and multiplying in their destined homes and habitats."

NOTES.—1854. ENTOZOA, page 11. The Entozoa might with great propriety be placed among the articulated animals, as many of them exhibit in their structure more of the articulated than of the radiate type. A very remarkable fact with regard to their development has been discovered—that some which continue as cystoid worms in the bodies of certain animals become changed into the higher form of the *Tænia* or Tape-worm, if transferred to the bodies of other animals. Vid. Siebold, translated from *Ann. Sci. Nat.* into Annals Nat. Hist., Dec. 1852. Page 431.

ZOOPHYTES, page 17. MEDUSÆ. p. 38, connexion between them.

Recent discoveries would go far to show that the separation of these classes "is unnatural, and that the Hydroid Zoophytes, at least, are very closely allied to, if not belonging to, the same natural order with the Pulmograde Medusæ.' "In what light are we to regard the relationship between the Medusa and the Polype? The one is not the larva of the other, as often improperly said, because there is no metamorphosis of the one into the other. The first is the parent of the last, and the last of the first; but neither is a stage of an individual's existence, destined to begin life as a Medusa, and end it as a Polype, and vice versa."

"IN THE CASE OF AURELIA, &c.

a. The medusa produces eggs.
b. The eggs produce infusoria.
c. The infusoria fix and become hydroid polypes.
d. The hydroid polypes produce medusæ by gemmation.

IN THE CASE OF CORYNE, &c.

a. The zoophytes produce medusæ by gemmation.
b. The medusæ produce eggs.
c. The eggs produce infusoria.
d. The infusoria fix and become zoophytes." Professor Edward Forbes, Monograph of the British naked-eyed Medusæ, published by the Ray Society.

ARTICULATA.

ARTICULATED, OR JOINTED ANIMALS.

———"Whatever creeps the ground,
Insect or worm; those waved their limber fans
For wings, and smallest lineaments exact
In all the liveries deck'd of summer's pride,
With spots of gold and purple, azure and green;
These, as a line, their long dimensions drew,
Streaking the ground with sinuous trace."—MILTON.

THE traveller who passes the line of demarcation which separates two adjacent kingdoms, does not at once perceive any obvious change in their physical features or their natural productions, nor see anything in the manners or customs of the inhabitants to tell him that he has entered a new realm. Such is the case with the naturalist who has been an observer of the radiate animals, and enters the dominions of the articulated. The Leeches and Worms, among which he has come, present very much the same aspect as the vermiform or worm-shaped Echinodermata, from which he has parted. "Why," he asks, "should they be thus divided?"

The question is best answered by an examination of the internal structure. A difference in the nervous system is at once apparent. It is no longer arranged on the radiate type, but presents the brain in the form of a ring surrounding the throat (*Fig.* 36); a double nervous thread extends along the body at its lowest side, united at certain distances by



Fig. 36.—NERVOUS SYSTEM OF CARABUS.

double "ganglions," as these nervous masses are termed, from which are given off the nerves that proceed to the extremities. From the symmetrical disposition of these nervous centres, Mr. Owen has given to this sub-kingdom the name Homogangliata.* The body in general presents a corresponding symmetrical form, and consists of a repetition of rings or segments, as in the Earth-worm, or the Millepede (*Julus*, *Fig.* 37).



Fig. 37.—JULUS.

The articulated animals are arranged in the following classes:—

Annellāta,	Leeches, Earth-worms, &c.
Cirripĕda,	Barnacles and Acorn-shells.
Crustacea,	Crabs, Lobsters, &c.
Insecta,	Beetles, Bees, Butterflies, &c.
Arachnĭda,	Spiders, Scorpions, and Mites.

* From two Greek words, one signifying "similar," the other "a ganglion," or knot, being the mass of nervous matter from which the nerves diverge.

CLASS I.—ANNELLATA.

Leeches, Earth-worms, etc.

"Her divine skill taught me this,
That from everything I saw
I could some instruction draw,
And raise pleasure to the height,
Through the meanest object's sight."—G. Wither.

The most obvious external character of the Leech or the Earth-worm is the number of little rings of which the body is composed; and hence the Latin word "annellus," a little ring, suggests an appropriate and descriptive term for animals of this class.

The medicinal Leech and the common Horse-leech of our ponds are so well known, that the most incurious cannot fail,

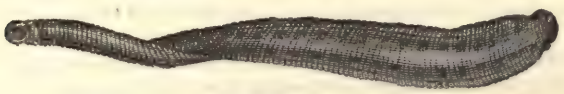


Fig. 38.—Leech.

at some period or other, to have noticed the singular disc with which these creatures are furnished at each extremity of the body, and which, at the will of the animal, can be used as a sucker, and thus converted into a support or point of attachment. Leeches are of many species; but these prehensile discs may be regarded as "the badge of all the tribe." They are destitute of external organs for locomotion, and move by the expansion and contraction of the segments of the body. In the water they can swim with ease and rapidity. Respiration is effected by a series of membranous sacs, which are analogous to internal gills, and to which water is freely admitted by minute orifices on the lower surface of the body.*

The medicinal Leech (*Hirudo medicinalis*) is not indigenous to Ireland; it is found in some parts of Britain, but is now becoming very rare. It is still seen in the lakes of Cumber-

* Jones's Nat. Hist. of Animals.

land, but even there is rapidly disappearing. This fact is mentioned by Wordsworth's leech-gatherer, in a stanza which casually notices, at the same time, the manner in which they are collected.

> "He with a smile did then his words repeat;
> And said, that, gathering leeches, far and wide
> He travelled; stirring thus about his feet
> The waters of the pools where they abide.
> Once I could meet with them on every side,
> But they have dwindled long by slow decay;
> Yet still I persevere, and find them where I may."
>
> *Resolution and Independence.*

The supply of leeches used in these countries is derived from France, Sweden, Poland, Hungary, the frontiers of Russia, and Turkey; and the great extent of the trade thus carried on may be judged of from the fact, that "four only of the principal dealers in London import 7,200,000 annually."*

When we find that the medicinal Leech has been applied to the use of man from a remote antiquity, and now constitutes so important an article of commerce, we are naturally led to inquire, "to what peculiarity of structure is its utility owing?" The first and most obvious is that by which its wound is inflicted. Just within the margin of the mouth "are situated three beautiful little semicircular horny saws, arranged in a triradiate manner, so that their edges meet in the centre."† "No sooner is the sucker firmly fixed to the skin than the mouth becomes slightly everted, and the edges of the saws thus made to press upon the tense integument, a sawing movement being, at the same time, given to each," they cut their way to the sluices of blood beneath. Nearly the entire body of the animal consists of a series of chambers into which the blood thus taken is received. They are eleven in number, perfectly distinct, and in the first eight the blood may remain for months unchanged either in colour or fluidity, the creature merely allowing so much to pass into the alimentary canal as is necessary to preserve its existence.‡ Hence the repugnance of the animal to repeat the operation, until the store of food with which it is thus gorged has been consumed.

The term *Leech* (derived from the Anglo-Saxon verb

* Penny Cyclopedia, Article Leech.
† Jones's Natural History of Animals, vol. i. page 322
‡ Owen, page 133.

læce, to cure, to heal) was applied by our old writers, not only to the animal, but also to persons, both male and female, who were skilful in the art of healing.

Thus, in the ancient Ballad of Sir Cauline, the king calls upon the princess to exercise her skill on behalf of the wounded knight:—

> "Come down, come down, my daughter deare,
> Thou art a leeche of skille;
> Farre lever had I lose half my landes,
> Than this good knight sholde spille."

The young of the leech are produced from cocoons* deposited by the mother towards the end of summer. The winter is passed by our common horse-leech (*Hæmopsis sanguisuga*) in a state of torpidity, in the mud at the bottom of the ponds or ditches where it resides. This habit gave origin, on one occasion, to a somewhat singular scene, which we chanced to witness. On the morning of the 27th March, 1838, a part of the footway on one of the most crowded thoroughfares adjoining the town of Belfast, was so covered with leeches, that it was scarcely possible to walk without trampling them under foot. So great was their abundance that some of the passers-by remarked, that it seemed as though a shower of leeches had fallen. They extended for about 100 paces in this profusion; on both sides of this space they were less numerous. The phenomenon continued for the two following mornings, but with diminished numbers. A slight examination served to explain its cause. The ditch on the side of the fence which separated the footway from the adjacent fields had been cleaned out the preceding day. The leeches had been buried in the slime, and on this being placed on the top of the fence, they had struggled out, and spread themselves over the adjoining footway.

The earth-worms represent another tribe of Annelids. In them suctorial discs, such as those of the leeches, do not exist; but a mechanical contrivance of a different kind may be observed. The rings, of which their body is composed, are no longer perfectly smooth; but are furnished with minute bristles, or recurved hooks. These, as the creature pushes its way, catch upon the soil, and form fixed points of support, by which the worm is enabled to maintain its place while drawing

* Owen, page 145.

forward the remaining parts of the body. Earth-worms move but little abroad during the day-time, except when disturbed. The young are produced from eggs, which, previous to their being deposited by the mother, have undergone a certain degree of development.* Their blood is red; but in some species it is yellow, and in one it is a pale green, so that the mere colour of the circulating fluid does not seem to be of the zoological importance attached to it by Aristotle.

The mouth of our common Earth-worm (*Lumbricus terrestris*) has a short proboscis, but is destitute of teeth. Its food consists of the decaying particles of animal and vegetable matter, "the crumbs that fall from nature's bounteous table."† By the ordinary process of chemical decomposition, these particles would be dissolved and lost. Swallowed by the Earth-worm, they become converted into nutriment, are assimilated to the substance of its body, and in this state minister to the support of beings of higher organization—to that of birds and fishes.

On this subject, the Rev. Gilbert White, in his delightful "Natural History of Selborne," has long since made the following judicious observations:—

"The most insignificant insects and reptiles are of much more consequence, and have much more influence in the economy of nature, than the incurious are aware of; and are mighty in their effect, from their minuteness, which renders them less an object of attention, and from their numbers and fecundity. Earth-worms, though in appearance a small and despicable link in the chain of nature, yet, if lost, would make a lamentable chasm. For, to say nothing of half the birds, and some quadrupeds, which are almost entirely supported by them, worms seem to be the great promoters of vegetation, which would proceed but lamely without them, by boring, perforating, and loosening the soil, and rendering it pervious to rains and fibres of plants, by drawing straws and stalks of leaves and twigs into it, and, most of all, by throwing up such infinite numbers of lumps of earth called worm-casts, which being their excrement, is a fine manure for grain and grass."

The correctness of these views has recently received a

* Owen, page 146.
† Rymer Jones, page 328.

curious confirmation, in a paper communicated by Mr. Darwin* to the Geological Society of London, in Nov. 1837. He observes that, in a pasture field which has long remained undisturbed, not a pebble will be seen, although, in an adjoining ploughed field, a large proportion of the soil may be composed of loose stones. This he attributes to the working of worms, and states his conviction, that every particle of earth in old pasture land has passed through the intestines of worms; and hence that, in some senses, the term "animal mould" would be more appropriate than "vegetable mould." It has been estimated that, in eighty years, the marl laid upon a field for manure, has been covered with soil to the depth of thirteen inches, by the operations of these creatures.

"It is commonly supposed," says Dr. Carpenter, "that the earth-worm may be multiplied by the division of its body into two pieces, of which each will continue to live. This, however, does not appear to be the case with regard to the common species. If it be divided across the middle, when in motion, each part will continue to move for a time; but only the piece which bears the head will be found alive after a few hours. This forms a new tail, and soon shows little sign of injury. But if the division be made near the head, the body will remain alive, and will renew the head; and the head, with its few attached segments, will die."†

The power of reproduction is enjoyed by many other Annelids to a much greater extent. A small worm (*Lumbricus variegatus*) was cut by Bonnet, a French naturalist, into twenty-six parts, and "almost all of them reproduced the head and tail, and became so many new and perfect individuals. It sometimes happened, that both ends of a segment reproduced a tail. Wishing to ascertain if the vegetative power was inexhaustible, Bonnet cut off the head of one of these worms, and, as soon as the new head was completed, he repeated the act; after the eighth decapitation, the unhappy subject was released by death."‡

In some species, the propagation reminds us of that of which we saw examples in the Infusoria. Thus, "in the *Nais*,§

* *Vide* Note to White's Selborne, edited by Rev. L. Jenyns, 1843, and Penny Cyclopedia, art. *Lumbricus*.

† Zoology, vol. ii. page 310. ‡ Owen, page 143. The accuracy of such statements has been denied by Dr. Williams (Rep. Brit. Ass., 1851), and affirmed, as regards the Earth-worm, by the late G. Newport, Esq. (Annals Nat. Hist. May, 1854, p. 423.)

§ Carpenter's Physiology, page 549.

one of the marine worms, the last joint of the body gradually extends, and increases to the size of the rest of the animal; and a separation is made by a narrowing of the preceding joint, which at last divides. Previously to its separation, however, the young one often shoots out a young one from its own last joint, in a similar manner, and three generations have thus been seen united." It is a curious circumstance, that the same tail serves as the tail of successive individuals, and seems thus to enjoy an exemption from the ordinary laws of mortality.



Fig. 39. ARENICOLA.

Respiration in the earth-worm is carried on by means of pores and internal sacs, similar to those of the leech. In the "lob-worm,"* or "lug of fishermen (*Fig.* 39), a portion of the body is furnished with little arborescent (tree-like) tufts, to which the blood is conveyed, and there purified, by coming into contact with the air diffused through the sea-water.

In the next tribe of Annelids, a new modification of the respiratory organs is exhibited, one admirably adapted to their peculiar habitats and modes of life. All the individuals of this assemblage dwell in tubes, consisting either of calcareous matter, secreted from their own bodies, or, as in the Terebella, of particles of sand and gravel agglutinated together to serve as a habitation. Under these altered circumstances, the only place to which the vivifying principle of the sea-water could freely have access, would be that adjacent to the exterior orifice of the tubes; and here, accordingly, we find the respiratory apparatus arranged, often extremely graceful in its form, and enriched with brilliant colouring. The small contorted tubes which encrust, in so fantastic a manner, the old bottles or dead shells dredged up from any of our bays, form an example of this class. They are the dwellings of one of these sedentary worms,

* This was formerly classed with the earth-worm, under the name of *Lumbricus marinus;* but, from its difference of structure, it is now referred to a different order (*Dorsibranchiata*), and bears the name *Arenicola piscatorum.*

bearing the name of *Serpula* (*Fig.* 40). "If, while the contained animals are alive, they be placed in a vessel of sea-water, few spectacles are more pleasing than that which they exhibit. The mouth of the tube is first seen to open by the raising of an exquisitely constructed door, and then the creature cautiously protrudes the anterior part of its body, spreading out, at the same time, two gorgeous fan-like expansions of a rich scarlet or purple colour, which float elegantly in the surrounding water, and serve as branchial or breathing organs."*



The minute convoluted shells (*spirorbis*), which are seen like whitish specks upon almost every piece of sea-weed, exhibit an instance no less striking of the same exquisite design, the same admirable adaptation of means to the required end.

The fourth tribe present, in their habits, a complete contrast to the last. They are formed for locomotion, and some among them can swim with considerable swiftness (*Fig.* 41). The roving life they lead has induced

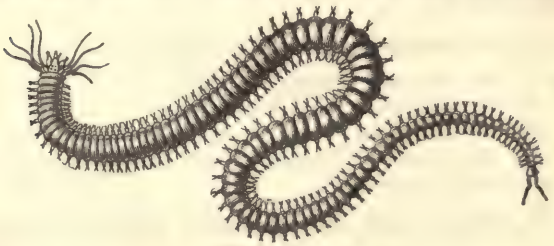


Fig. 41.—Nereis.

Milne Edwards, the eminent naturalist, whose classification we have followed, to bestow on them the characteristic appellation of *Errantes*.†

* Jones's Natural History of Animals, page 313.

† Recherches pour Servir à l'Histoire Naturelle du Littoral de la France. Paris, 1834.

They present considerable diversity in size. In one tribe (*Nemertina*) there are individuals not more than one or two inches long, while others, of the same fraternity, attain the enormous length of fifteen feet,* or, when artificially distended, of more than twenty yards.† The sea long-worm, for so this species is named (*Nemertes Borlasii*), contracts in spirits to one or two feet in length, and the thickness of an ordinary quill. One was taken by Captain Fayrer, "holding on to a bait on his long line, when he was fishing for cod off Portpatrick."‡

In contrast with the freebooter, thus made prisoner while on a predatory excursion, we may mention a species which is so much broader and thicker than other Annelids as to have lost its worm-like aspect. It is common around our coast, and is popularly known as the sea-mouse (*Aphrodita aculeata*). Besides being furnished with numerous fasciculi, or bunches of stiff, sharp-pointed bristles, employed both as organs of motion and weapons for defence, it is decorated with numerous soft, silky hairs, of the most brilliant metallic colours, and highly iridescent. Strange it may seem to us, that a worm, living in the midst of the slime at the bottom of the sea, should have a vesture which rivals, in the splendour of its hues, the wing of the butterfly, or the plumage of the humming-bird! But the beauty impressed on even the humblest of created beings seems boundless as the beneficence of Him who called them into being.

We have enumerated four tribes of Annellata:—

I. The Suctorial, comprising the Leeches;
II. The Terricolous, including the Earth-worms;
III. The Tubicolous, which inhabit tubes;
IV. The Errantes, which are the most highly organized, and the most locomotive.§

In respect to some worms, there are traditionary errors

* Dr. Johnston in Mag. of Zoology and Botany, 1837, page 536.

† This we state on the authority of Mr. R. Ball, who took one at Clifden, Co. Galway, which he ingeniously caused to distend itself, and was thus enabled to ascertain its measurement.

‡ W. Thompson in Mag. Nat. Hist. vol. ii. No. 13.

§ Their respiratory organs are placed upon the back; hence the term applied to them by Cuvier, *Dorsibranchiate*, from *Dorsum*, the back; and *branchiæ*, gills.

which are still current. Thus, there is a species, called the Hair-worm (*Gordius aquaticus*), which is abundant, during a part of the summer, in rivulets in the North of Ireland and elsewhere. Its length is about eight or ten inches, and the common superstition about it is, that horse-hairs placed in water become vivified, and are changed into these worms. This notion, with the addition that the Hair-worm was the young state of the serpent, was prevalent in the days of Queen Elizabeth, for we find it is thus recorded by Shakspeare,—

> ——"Much is breeding,
> Which, like the courser's hair, hath yet but life,
> And not a serpent's poison."

The writings of the same poet furnish us with examples of the comprehensive manner in which the word "worm" is used, and of its application to objects different from those to which it is restricted by the naturalist.*

Among these humble animals are some which possess luminous properties: one has been observed in Ireland on some of the extensive tracts of bog; and to Mr. R. Ball we are indebted for the following notice of a similar power in one of the marine species:—"The most beautiful instance I ever saw, of luminous animals, occurred when I was passing at night, between the Islands of Arran, in the Bay of Galway. My attention being attracted by spanglings of light on the field of Zostera (grass-wrack) below, I let down my small dredge. On its touching the bottom, a blaze of light flashed from the Zostera, and as the boat was pulled along, the dredge seemed as if filled with liquid molten silver. On drawing it up, I found the light to proceed from numbers of a very small species of Annelid; these little animals were bright red, and so soft that they could not be taken out of the dredge. Any attempt at preservation would have been vain. By day-light, it is probable, their very existence would have been unnoticed, so little conspicuous were they. An idea of the size and

* "The *worms* were hallowed that did breed the silk."—OTHELLO.
"A convocation of politic *worms*."—HAMLET.
"Hast thou the pretty *worm* of Nilus here, that kills and pains not?"
ANTONY AND CLEOPATRA.
"Your *worm* is your only emperor for diet."—HAMLET.
"There the grown serpent lies; the *worm* that's fled
Hath nature that in time will venom breed."—MACBETH.
"Eyeless venom'd *worm*."—TIMON OF ATHENS.

luminosity of the Annelid may be formed, by supposing its body to be represented by the slit in a silver spangle, and its luminosity by the disc of the spangle."*

Some among these creatures occasionally present themselves to our notice in situations where they would be least expected. Thus, Templeton describes one (*Spio calcarea*) "living in minute tubular cavities, in our limestone rocks, the tentacula alone projecting, and kept by the animal in constant motion."† We have noticed the same, or some allied species, in rock pools on the County Down coast, where there is no limestone. There the pinkish substance, now regarded as vegetable,‡ that lined the pools, formed the materials of its dwelling, and the minute waving tentacula gave animation and interest to the otherwise quiet little basins.

CLASS II.—CIRRIPEDA.

Barnacles and Acorn-shells.

"There are found in the north parts of Scotland and the islands adjacent, called Orchades, certain trees, whereon do grow certain shells of a white colour, tending to russet, wherein are contained little living creatures; which shells in time of maturity do open, and out of them grow those little living things, which, falling into the water, do become fowls which we call Barnacles."

The words which we have selected as the motto for the present chapter occur in Gerardes' "Herbal, or General History of Plants," a work published in 1597, and regarded for more than a century afterwards as one of the best sources of botanical information. Its author resided in Holborn, and established there a "physic garden" of his own, which was probably, at that period, the best of its kind in England for the number and variety of its productions. The transformation above mentioned he gives on the authority of others. "Thus



* As all our readers may not be familiar with the ornament to which our friend, Mr. Ball, has referred, we annex a wood-cut, which will render his illustration more perfectly understood.

† Mag. Nat. Hist. vol. ix. page 233.

‡ *Millepora polymorpha.*

much by the writings of others, and also from the mouths of people of those parts, which may very well accord with truth." He then proceeds in a strain which marks the downright sincerity of this honest and laborious old naturalist, who had mistaken the soft parts of the barnacle for a bird. "But what our eyes have seen and our hands have touched, we shall declare. There is a small island in Lancashire, called the Pile of Foulders, wherein are found the broken pieces of old and bruised ships, some whereof have been cast thither by shipwreck, and also the trunks and bodies, with the branches, of old and rotten trees cast up there likewise, whereon is found a certain spume or froth, that in time breedeth unto certain

BARNACLES.



Fig. 42.—Shell of Lepas.



Fig. 43.—Body of Lepas.

shells in shape like those of a mussel, but sharper pointed and of a whitish colour; wherein is contained a thing in form like a lace of silk finely woven, as it were, together, of a whitish colour, one end whereof is fastened unto the inside of the shell, even as the fish of oysters and mussels are; the other end is made fast unto the belly of a rude mass or lump, which in time cometh to the shape and form of a bird: when it is perfectly formed, the shell gapeth open and the first thing that appeareth is the foresaid lace or string; next come the legs of the bird hanging out, and, as it groweth greater, it openeth the shell by degrees, till at length it is all come forth, and hangeth only by the bill. In short space it cometh to full maturity, and falleth into the sea, where it gathereth feathers and groweth to a fowl bigger than a Mallard and lesser than a Goose."

The specific name, *Anatifera*, or goose-bearing, by which the most common kind of barnacle-shell (*Lepas*) is distinguished, commemorates this old traditionary error, which is still current. On more than one occasion, when we have been examining a sea-borne piece of timber, with its crowd of suspended Barnacles, some casual spectator has volunteered to point out to us the bill and feathers of the future bird!

We may smile at the extravagance of these ideas, and wonder how fancy could have devised such tales. But the wildest stretch of imagination could not venture upon anything more wonderful than the real and simple facts respecting the transformations of these animals.

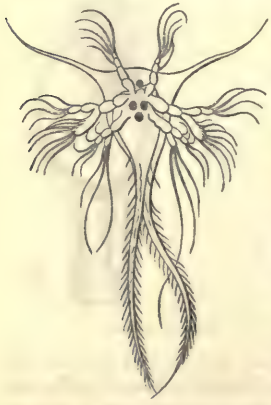


Fig. 44.—Young of Lepas.

Before the shelly covering of that Barnacle was secreted, the creature, not fastened as now by its fleshy pedicle, was free and locomotive, with members well adapted for swimming, and furnished, like the fabled Cyclops, with one central eye (*Fig.* 44). The animal of that acorn-shell, now fixed so immoveably upon the rock, had, at one time, an elliptic figure, two eyes mounted upon footstalks, and six pair of jointed legs, which, keeping stroke like so many oars, propelled it onwards (*Fig.* 45). At a certain period its erratic habits were laid aside, its future resting-place was selected, and then, attaching itself securely to the place thus chosen, its shelly covering was secreted, and as the process went on, the visual powers, no longer needful for the welfare of the animal, were extinguished for ever.



Fig. 45.—Young of Balanus.

To Mr. J. V. Thompson, whose name we have already had occasion to mention, we are indebted for the discovery of these metamorphoses, which the researches of other observers

have amply confirmed.* Mr. Thompson, in the spring of 1826, took, in a small towing-net, a number of minute translucent creatures about the tenth of an inch in length and of a somewhat brownish tint.† They were taken on the first of May, and kept alive in a glass of sea-water. They appeared like small crustacea. On the night of the eighth, two of them had thrown off their outer skin, and were firmly attached to the bottom of the vessel, when they rapidly assumed the apparel of the sessile Barnacles or Acorn-shells (*Balanus pusillus*).

The pedunculated Barnacles, or those with the long pedicle, present, in their young state, an appearance very dissimilar; but, in all essential particulars, the change from their transitory swimming condition to their permanently adhesive state is precisely similar. In their perfect state (*Figs.* 42, 43) they are described by Mr. Owen as being "symmetrical animals, with a soft unarticulated body enveloped in a membrane. They are provided with six pair of rudimentary feet, obscurely divided into three joints, and terminated each by a pair of long and slender, many-jointed, ciliated tentacles, curled towards the mouth, and thence giving origin to the name of the class" (*Cirripeda*, curl-footed).‡

The Acorn-shell is based on a deposit of calcareous matter, and has a shell composed of many pieces, and thus capable of enlargement according to the wants of the animal. It was formerly classed with the Barnacle among the Multivalve shells, the contained animals being regarded as Mollusca, or to use a more common phrase, as "shell-fish." Their structure and their changes being now better understood, they constitute of themselves a small but interesting class, allied to that of the crustaceous animals, which constitute the next division. The sexes have been ascertained to be distinct.§

The cheapness of the pleasures which natural history affords should of itself form a reason for the general cultivation of such pursuits. They are within the reach of the most humble, and are not dependent on costly or complicated apparatus. By means so simple as a glass of sea-water, we have caused the Balani or Acorn-shells to exhibit a series of movements, which we have never shown to the youth of either sex without

* Vide ante, page 46.
† Zoological Researches, Memoir iv. page 78, plate xi.
‡ Lectures, page 155.
§ H. D. Goodsir, in Edinburgh Philosophical Journal, July, 1843.

hearing from them expressions of the most unfeigned delight. Let the reader try the experiment. Go at low water to a rock on the beach, choose a few of the oldest and largest Limpets, left uncovered by the receding tide, and encrusted with the Acorn-shells. As the enclosed animals have then been without nourishment for two or three hours, they will be quite ready for another meal. Throw the Limpet-shells into the glass of sea-water, and in a minute or two the Acorn-shells upon them will begin to open. Presently a beautiful feathered apparatus (*Balanus, Fig.* 46) will be extended, then withdrawn. It will again be put forth, and again retracted; but with such grace, regularity, and precision, that the eye regards it "with ever new delight." And when the same exquisite mechanism is exhibited by every one of them, either in succession or simultaneously, and when we consider that it thus ministers, at the same moment, both to respiration and nutrition, a train of ideas is excited, which rises from the humble shell to HIM by whom it has thus wondrously been fashioned.



Fig. 46.
BALANUS.

NOTE.—*Nov.* 1856.—A valuable monograph on the Cirripedes, by Darwin, has been published by the Ray Society.

CLASS III.—CRUSTACEA.
CRABS, LOBSTERS, SHRIMPS, &c.

——"What is man,
If his chief good, and market of his time,
Be but to sleep and feed? A beast—no more.
Sure He that made us with such large discourse,
Looking before and after, gave us not
That capability and godlike reason
To fust in us unused."—SHAKSPEARE.

"THE name of this class," says Professor Owen, "refers to the modification of the external tegument by which it acquires due hardness for protecting the rock-dwelling marine species from the concussion of the surrounding elements, from the attacks of enemies, and likewise for forming the levers and points of resistance in the act of supporting the body, and

moving along the firm ground. In the Crab and Lobster tribes, the external layer of the integument is hardened by the addition of earthy particles, consisting of the carbonate, with a small proportion of the phosphate, of lime."* In the smaller species it is more flexible, resembling the texture of horn or parchment.

Distribution.—The Crustacea are universally diffused, not only throughout the ocean, but through ponds, lakes, ditches, and running waters. In the polar seas they are found in great abundance, though the number of species is very limited. In the equatorial regions, while they are no less numerous, they present a greater diversity of form, attain a larger size, and exhibit, in the highest perfection, those peculiarities of structure by which the several groups are characterised. But though "the world of waters is their home," they are not confined within its boundaries, for there are some species which are occasional visiters to the land, and others which make it their permanent residence.

Form.—Their figures, when most faithfully delineated, present a variety of form so great that at first sight they seem in some cases to be the offspring of a fantastic fancy, rather than the correct delineation of living animals. We find legs so formed as to do the work of jaws (*Fig.* 56—60); others so constituted as to perform the function of gills; while some are so long and so slender that, were we to judge merely from appearance, they would seem quite disproportioned to the size of the body to which they are appended.

Characteristics.—As, in the radiated animals, we found the radiated structure most apparent towards what may be considered the centre of the group, so here we may point to the Crustacea as examples of the complete development of the jointed or articulated structure. In them we find the respiratory apparatus existing as branchiæ or gills, however varied its position or arrangement. The sexes are distinct, and all the individuals are free and locomotive. "It is the combination of branchiæ with jointed limbs and distinct sexes which constitute the essential characters of the class Crustacea."*

Integument.—As the integument is inelastic, and does not admit of enlargement to suit the growth of the animal, a

* Lectures, page 163.

beautiful provision exists, by which it is from time to time thrown off, and its place supplied by one of larger dimensions. In two or three days, the new covering assumes the hardness of the old one; and, until then, the animal, as if conscious of its defenceless state, avoids, as much as possible, all exposure. We shall revert to this subject in treating of the best known native species.

Reproduction.—All of them possess the capability of reproducing extremities which are injured. Thus, if the leg of a Crab be fractured, it throws off the injured limb, near to the body. "It has the power of doing so apparently for two purposes—to save the excessive flow of blood which always takes place at the first wound, and to lay bare the organ which is to reproduce the future limb.* As soon as the injured limb has been thrown off, the bleeding stops; but if the animal is unable, from weakness or any other cause, to effect this, the result is fatal. The growth of the new limb is slow, until after the period of the next moult, when it rapidly assumes its full proportions."

Respiration.—Every one who has opened the "shell" of the common Crab, has noticed a number of leaf-like organs, regularly arranged in two parcels, with the points of the little leaves or plates in each parcel brought nearly together (*Fig.* 47). These are the branchiæ or gills, organs admirably adapted to the aquatic life of the animal. In the Lobster the arrangement of the parts is different (*Fig.* 48), being accommodated to the different form of the body, but providing no less effectually for the æration of the circulating fluid. In other Crustacea, the gills are formed like feathery tufts, and float freely in the water (*Fig.* 49); while, in one



Fig. 49.—Squilla.

* H. D. S. Goodsir, on "the Mode of Reproduction of Lost Parts in the Crustacea." Anatomical and Pathological Observations. Edinburgh, 1845.

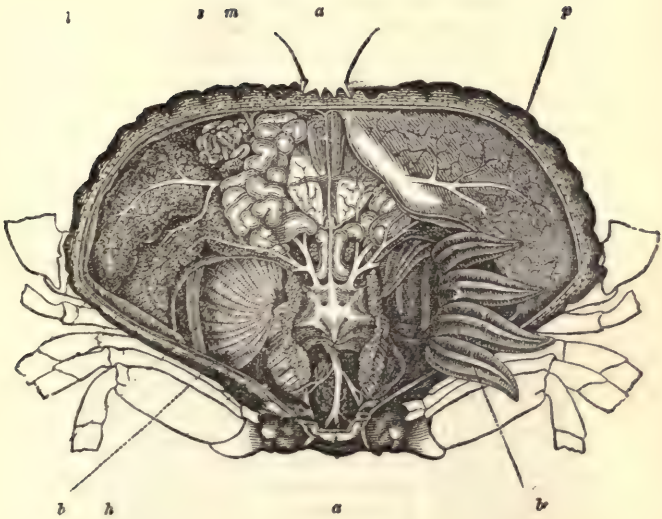


Fig. 47.—Anatomy of Crab.

Fig. 47.—*p*, Part of the lining membrane of the shell.—*h*, The heart.—*a*, Arteries.—*b*, Branchiæ in their natural position.—*b'*, Branchiæ turned back to show their vessels —*s*, Stomach.—*m*, Muscles of stomach.—*l*, Liver.

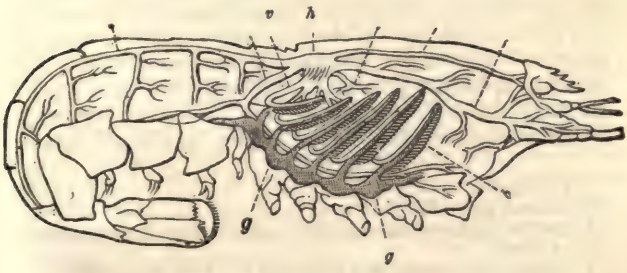


Fig. 48.—Circulatory Apparatus of Lobster.

Fig. 48.—*h*, Heart.—*g*, *g*, Sinus or dilated vein receiving the blood which comes from different parts of the body, and is thence sent to the branchiæ *b*, from which it returns to the heart by the branchial veins, *v*.

division, termed, from the circumstances, "gill-footed,"* the surface of the legs is extended, and made subservient to respiration. From this cause, in the minute tribes in which this structure prevails, the feet are sometimes seen in motion when the body is at rest. The more actively the body moves, the more brisk will be the circulation; "and since," as Mr. Owen remarks, "the muscular energy directly depends upon the amount of respiration, the two functions are brought into direct relation with each other by the simple connexion of their respective instruments."†

In those tribes that live partially or altogether on the land, the respiratory apparatus is modified, but is still in its most essential features, aquatic. In the Wood-louse (*Oniscus*,‡ *Fig.* 50), which lives in dark and damp situations, respiration is effected by a series of plates, at the lower side of the abdomen.§ In the Land-crabs, contrivances of different kinds exist, to retain so much water as will supply the gills with the amount of moisture needful for the due performance of their functions. But the quantity of oxygen which water only can furnish is insufficient for animals whose respiration is so active. They must have access to air, or they inevitably perish. Hence we are able to understand why it is that they are drowned, if immersed for any long time in water.



Fig. 50.—Oniscus.

Vision.—In the eyes of the Crustacea a great diversity of structure is exhibited. Some species are furnished with two placed upon distinct peduncles or stalks; others have eyes of the same formation, but the peduncle is wanting; such eyes are therefore described as being "sessile" or sitting. In one

* Phyllopoda.

† Lectures, page 182.

‡ The *Oniscus* is well-known, in the North of Ireland, by the provincial name of *Slater*.

§ Some of these animals have been found in a fossil state in Wiltshire, in those secondary rocks termed the Wealden formation. The eyes which, like those of the Trilobite, hereafter mentioned, are composed of a number of separate lenses, form beautiful objects when magnified. They are sometimes found not attached to the head, but loose in the limestone.—Fossil Insects in the Secondary Rocks of England, by the Rev. P. B. Brodie. London, 1845.

genus (*Daphnia*) a "smooth, undivided cornea protects and transmits the rays of light to an aggregation of small ocelli,"* or eye-specks; while in a fossil species (*Asaphus caudatus*, *Fig.* 51) we have an example of the cornea itself being divided into at least 400 compartments, each supporting a circular prominence, the whole being so arranged that where the distinct vision of one ceases, that of another begins.

Among the crustaceous animals now extinct, but whose remains are found in some parts of England and Ireland, and in other countries, is one tribe which, from the three longitudinal divisions of which the body is composed, is known

TRILOBITES.†



Fig. 51.

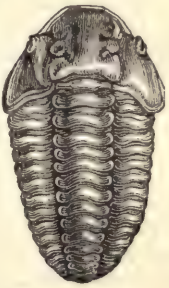


Fig. 52.

by the name of *Trilobites* (*Figs.* 51, 52). In these fossils, one of which has been mentioned in the preceding paragraph, the compound structure of the eyes is so well developed and preserved, that we are enabled to compare it with that of existing species. This circumstance happily suggested to the very Rev. Dr. Buckland a train of reasoning respecting "the condition of the ancient sea and the ancient atmosphere, and the relations of both of these media to light," which furnishes so admirable an example of the manner in which knowledge in one department throws light upon researches in another, that we give the passage in full.

"With respect to the waters in which the Trilobites‡ maintained their existence throughout the entire period of the

* Owen, page 175.

† Fig. 51.—*Asaphus caudatus.* Fig. 52.—*Calymene Blumenbachii.*

‡ Bridgewater Treatise, vol. i. page 401.

transition formation, we conclude that they could not have been that imaginary, turbid, and compound chaotic fluid, from the precipitates of which some geologists have supposed the materials of the surface of the earth to be derived; because the structure of the eyes of these animals is such, that any kind of fluid in which they could have been sufficient [for vision] at the bottom, must have been pure and transparent enough to allow the passage of light to organs of vision, the nature of which is so fully disclosed by the state of perfection in which they are preserved. With regard to the atmosphere, also, we infer that, had it differed materially from its actual condition, it might so far have affected the rays of light, that a corresponding difference from the eyes of existing Crustaceans would have been found in the organs on which the impressions of such rays were then received."

"Regarding light itself, also, we learn from the resemblance of these most ancient organizations to existing eyes, that the mutual relations of light to the eye, and of the eye to light, were the same at the time when Crustaceans, endowed with the faculty of vision, were first placed at the bottom of the primeval seas as at the present moment.

"Thus we find, among the earliest organic remains, an optical instrument of most curious construction, adapted to produce vision of a peculiar kind, in the then existing representatives of one great class in the articulated division of the animal kingdom. We do not find this instrument passing onwards, as it were, through a series of experimental changes, from more simple into more complex forms; it was created, at the very first, in the fulness of perfect adaptation to the uses and condition of the class of creatures to which the kind of eye has ever been, and is still, appropriate."

Ova.—All crustacea are produced from fertilized ova, which the female, after they have passed from the oviduct, continues to carry about with her until they have attained a certain amount of development. Various are the appendages employed for this purpose; perhaps no example will be more generally known than the one afforded by the common lobster when "in pea."

Metamorphoses.—The young do not, on their liberation from the ova, present a miniature resemblance to the species to which they belong. The contrary opinion was formerly entertained, and it was even regarded as one of the charac-

teristics of the higher crustacea, that they did not undergo a metamorphosis. It will not be uninstructive to advert briefly to the observations, which have led to more correct ideas on this subject.

In a Dutch work, published in 1778, there appeared the figure of a small crustaceous animal (*Fig.* 53), unlike any previously known. A French naturalist took another in the Atlantic, five or six hundred leagues from the coast of France, and included both under the generic appellation of *Zoea*. A third was taken in the course of Captain Tuckey's voyage to the Congo, and two were observed by Mr. J. V. Thompson when returning, in 1816, from the Mauritius. All the five specimens were those of distinct species, and constituted the only examples known of these crustacea until the spring of 1822. In that year, Mr. J. V. Thompson, to his great surprise, met with *Zoeas* in considerable abundance in the Cove of Cork. Further research showed that these animals, which had been regarded as so rare that the capture of each was recorded as an event, were to be found in vast profusion in our bays and estuaries; and instead of being perfect and anomalous creatures, were but the immature state of the common crabs!



Fig. 53. Zoea (Magnified).

The observations of Mr. Thompson, amply corroborated by those of other naturalists, have established the fact, that the crustacea undergo metamorphoses; but to what extent this takes place in the several tribes, we are as yet unable to determine. Here is an ample field for inquiry, in which the careful accumulation of facts, and even the collecting of specimens, may render good service to the cause of science.

The young state of the crabs, that to which the term *Zoea* was formerly applied, exhibits, so far as known, a different appearance in each species. The one in which our readers will be most interested is the common edible crab (*Cancer pagurus*), and those who have only seen the animal in its mature condition will perhaps be surprised to learn that it existed at one time under the form repre-

sented in *Fig.* 54, its members being adapted for swimming, and its body so minute that its natural size, when in that state, is shown by the speck adjoining the letter *n*.



Fig. 54.—Young of the Common Crab.*

Land-crabs.—In the limited space to which, in a work of this kind, we are necessarily restricted, it is only our intention to notice the habits of a small number of our native species; but the land-crabs of foreign countries constitute a group too remarkable to be altogether omitted. Of the genus Thelphusa† (*Fig.* 55), one fresh-water species, a native of the rivers of southern Europe, was well known to the ancients, who often represented it on their medals. Colonel Sykes states, that another species is found in the valleys along the Ghāts in India, and also on the most elevated table-lands.‡ They are there not only numerous but troublesome, intruding themselves into the tents, and even invading such beds as are placed on the ground. He also informs us, that the table-land of the elevated hill-fortress Hurreechundurghur, 3900 feet above the sea, is inhabited by such multitudes of land-crabs that their burrows render



Fig. 55.—Thelphusa.

* The figures 53, 54, and the information by which they are accompanied, are taken from "Zoological Researches," by J. V. Thompson. A Zoea, different from any of the species noticed by that author, is described by Templeton, in the Trans. of the Entomological Society, vol. ii. p. 114. It was taken by us in Larne Lough, County Antrim, in May, 1835.

† Carpenter's Zoology, vol. ii. page 250. *Vide*, also, Milne Edwards' "Histoire des Crustaces," tome ii. page 10.

‡ Trans. Entomological Society, vol. i. page 182.

it unsafe to ride over many parts of the mountain. From his own observation, and from the concurrent testimony of the natives, he is of opinion that these Crabs do not migrate. Another Indian species is thus noticed in the Journal of Bishop Heber. "All the grass through the Deccan usually swarms with a small Land-crab, which burrows in the ground, and runs with considerable swiftness, even when encumbered with a bundle of food almost as big as itself; this food is grass, or the green stalks of rice, and it is amusing to see the Crabs sitting, as it were, upright, to cut their hay with their sharp pincers, then waddling off with their sheaf to their holes as quickly as their sidelong pace will carry them." The Land-crabs of the Antilles* have long been celebrated for their nocturnal and burrowing habits, and for the determination evinced, by some species, to take the most direct line to the coast, when the period of visiting the sea, for the purpose of depositing their eggs, has arrived.

Classification.—Among the numerous tribes of Crustacea, it is to be expected that at considerable difference must exist as to the nature of their food, and a corresponding difference in the form of their mouths, and the structure of those organs by which the food is taken. Some are furnished with jaws or mandibles suited for mastication; others with a beak or tubular apparatus adapted for suction. This enables us at once to separate the class into two great divisions, the masticating and the suctorial. There is, however, a tropical genus, the Limulus or King-crab (*Fig.* 56), whose mouth has no peculiar appendages, but is surrounded by legs,

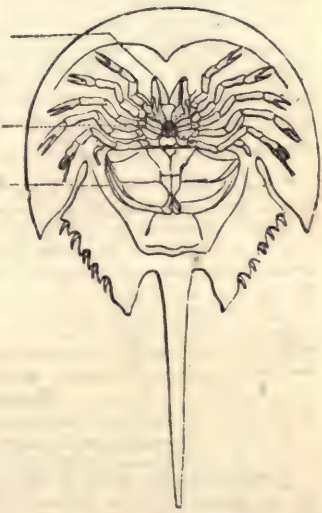


Fig. 56.—Limulus (reduced).

* *Gregarciniens.* Milne Edwards' Crustaces, vol. ii. page 18.

the bases of which perform the office of jaws; and for its reception a third division—*Xiphosura** has been specially constituted.

Reverting to our native species, we find some, as already mentioned (page 76), with the eyes on footstalks, others with the eyes sessile. This forms an excellent characteristic distinction. Again, some have the gills enclosed in the body, and have ten legs; others have the gills external, and the number of the legs or appendages variable. By such characters they are divided into sections, orders, sub-orders, genera, and species. All of those which are the best known and the most valued, are, with regard to their food, masticating (*Maxillosa*); have the eyes on footstalks (*Podophthalma*); and have ten legs (*Decapoda*).† These scientific terms, though startling to beginners, do nothing more than express, in a different form, the same meaning that the simple English words convey.

The animals composing the first group we shall mention among our native Crustacea, familiarly known as "Spider-crabs," from their length of legs. Mr. W. Thompson gives an instance of one of them (*Hyas aranea*) only two and a quarter inches across the "shell" which had an oyster three inches in diameter upon his back, and remarks that the Crab must have enacted the part of Atlas for some successive years, as the oyster was encrusted with large acorn-shells, and could not have been less than five years old.‡ A series of such observations would

* Sword-tailed. Figure 56 represents the lower surface of the animal. *m*, the Mouth.—*f*, Feet, the basis of which perform the office of jaws.—*a*, Abdominal appendages bearing the branchiæ.—*t*, Sword-shaped tail.

† In the ten-footed Crustacea (*Decapoda*), there is a striking difference in the form and development of the tail, as in the Crab and in the Lobster; and they are thus divided into two very natural groups. The Hermit-crabs, in which the tail is prolonged, but defenceless, may be regarded as a connecting link. Hence, Milne Edwards, in his excellent "Histoire des Crustaces," arranges them in three sections, distinguished by terms expressive of these peculiarities of structure. Thus:—

DECAPODA.

1st section, *Brachyura*, or short-tailed, as the Crabs.
2d „ *Anomoura*, or irregular-tailed, as Hermit-crabs.
3d „ *Macroura*, or long-tailed, as the Lobster, Cray-fish, &c.

‡ The information given in this page, and acknowledged elsewhere, by the initials, W. T. is derived almost exclusively from a paper on "the Crustacea of Ireland, order Decapoda," by William Thompson, Esq.; President Nat. Hist. Society, Belfast, published in Annals Nat. Hist. vols. x. xi. 1842–3; and we have not scrupled, on many occasions, to avail ourselves of the language there employed.

help us to a solution of the question, "what is the longevity of different species of Crustacea?" one which, at present, we are quite unable to answer. Those who wish to obtain specimens of the Spider-crabs, without going out to dredge for that purpose, will occasionally find them along with shells, Star-fishes, &c. in the stomachs of the Cod and the Haddock.

The Crabs used as food are, of course, those which are most valued and sought after. The large edible Crab is that which in the North of Ireland is known as *the* Crab (*Cancer pagurus, Leach, Fig.* 57). It is distributed round all our coasts, and is generally taken by wicker-baskets, like the cage-shaped wire mouse-traps, and baited with guts of fish, or other garbage; but it is also taken by means of a piece of hooked iron thrust into its retreats at low water. M. Edwards mentions that, on the French coast, their weight sometimes exceeded 5 lbs.; at Falmouth it has reached 14 lbs. In the London market they very commonly weigh 9 lbs.; and some equally large have been taken on the Irish coast. The smaller edible Crab of British authors (*Carcinus mœnas*) is the most common species round the entire coasts of Great Britain and Ireland, lurking beneath stones or tangle, or half concealed in the moist sand. It appears to be very tenacious of life. Some which were buried in a garden to the depth of twelve or fourteen inches, with a little sea-weed placed between them and the soil, were found alive at the end of seventeen days; and one individual evinced his customary promptitude in the use of his nippers.



Fig. 57.—Cancer Pagurus.

We learn from Leach* that this species "is sent to London in immense quantities, and eaten by the poor, who esteem it a great delicacy;" and M. Edwards observes it is used in like manner in Paris. It is never offered for sale in the markets

* Malacostraca Podopthalmata Britanniæ, Table 5.

of the North of Ireland, nor, as far as we know, is it ever employed there as an article of food. Mr. R. Ball states,* that when these Crabs are about to change their shells, or have recently done so, they are sought for under the sea-weeds, at low tide, by the fishermen at Youghal, chiefly as bait for flat-fish. In this soft state they are called *Pilcrabs*. From their habits of elevating their claws in a threatening attitude, when molested, they have, on the coast of Normandy, the name of "Crâbes enragés."

The Pea-crabs form an interesting group, from their diminutive size, and their singular habitation in bivalve shells, one of which was celebrated in connexion with the Crab; as,

"The anchored Pinna and her cancer friend."

The Pinna, according to tradition, being warned of the approach of danger by the alacrity of the little Crab, who was the joint and friendly occupant of her mansion. One species (*Pinnotheres pisum*) is so common on our Irish coast, that Mr. W. Thompson obtained fourteen of them, by opening eighteen of the large or "Horse-mussel," dredged off the County Down shore; and in the common Cockle at Youghal, Mr. Ball found them so abundantly, that about nine out of every ten Cockles contained a Crab. Two and even three Crabs are occasionally found in one Mussel, or one Pinna.

The Hermit-crabs belong to a different order. The tail is prolonged and soft, being destitute of the hard calcareous covering which protects the anterior portion of the body; and hence, in self-defence, the animal is obliged to occupy some univalve shell, which has been deserted by its original occupant. From the fact of each Crab being thus the solitary inmate of its retreat, the common English name has no doubt been bestowed. The species most abundant on our coast (*Pagurus Bernhardus*) is found in shells of very different dimensions, and from time to time leaves its abode, as it feels a necessity for a more commodious dwelling. It is said to present on such occasions an amusing spectacle, as it inserts the tail successively into several empty shells, until one is found to fit.† We learn from Professor Bell, however, that

* In Mr. W. Thompson's Paper.
† Carpenter's Zoology, page 252.

it does not always wait until the house is vacant, but occasionally ejects the rightful occupant *vi et armis*.*

In the Crustacea of the next order, the tail is not only longer but is different in form, being divided into five broad



Fig. 58.—Spiny Lobster (reduced).

flat pieces, so as to act with great effect upon the water. The common Lobster (*Homarus vulgaris*) is perhaps the best

* History of British Crustacea, page 173; Published by Van Voorst.

known example; it is taken all round the rocky portions of the coast. So much is it valued, that the finest flounders and plaice are, in some places, cut up to furnish the most tempting bait for the Lobster-pots.* Another species, the Spiny Lobster (*Palinurus vulgaris, Fig.* 58), attains even larger dimensions, being occasionally taken of eighteen or twenty inches in length, and weighing so much as twelve or fifteen pounds.* It frequents deep water, and only approaches the shores in spring, for the purpose of laying its eggs.

The Cray-fish (*Fig.* 59) inhabits rivers in many parts of

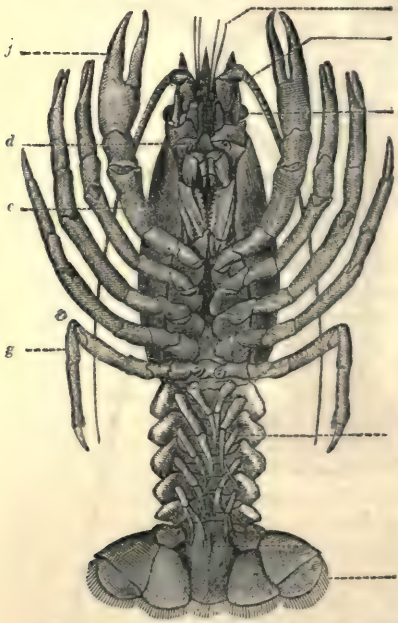


Fig. 59.—Cray-fish (reduced).†

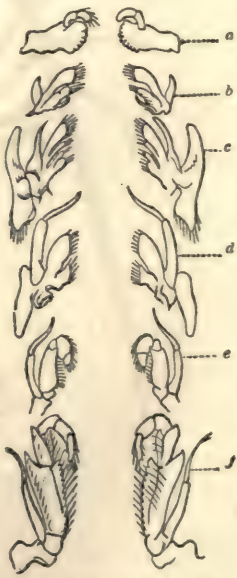


Fig. 60.—Masticating apparatus.‡

* W. T.

† Fig. 59.—Exhibits the lower side of the Cray-fish. *a* and *b*, Antennæ.—*c*, Eyes.—*d*, Auditory tubercle or organ of hearing.—*e*, External feet-jaws.—*f*, First pair of thoracic legs.—*g*, Fifth pair.—*h*, Abdominal false legs.—*i*, Tail formed for swimming.

‡ Fig. 60.—Shows, in their detached state, the six pair of appendages which constitute the apparatus for mastication. *a*, Mandibles.—*b* and *c*, First and second pair of jaws or maxillæ.—*d*, *e*, *f*, Three pair of feet-jaws.

Ireland, but is generally stated to have been introduced. It is said to be possessed of great longevity: M. Edwards asserts, that it lives for more than twenty years, and continues to grow during that entire period.* It is the office of the males to cater for the female and young; and a very intelligent observer states, that he has frequently seen them catching and breaking up small fish as their food.† On being disturbed, both sexes gather their young under their tails; but a singular difference prevails between the sexes, with regard to the manner of protecting their progeny. The male, on being lifted, retains them under his tail; but the female, on being captured, wiser than her lord, "slaps" them into the water with such force as to produce the effect of a shower of rain upon the surface.

The cast-off shell of many of the Crustacea preserves its former appearance so completely as to exhibit the form of the animal, and even its most minute appendages. This we have not been so fortunate as to observe, but it is fully confirmed by the following note from Mr. R. Ball, who adds, at the same time, some other particulars, illustrative of habits. "Some years ago, I kept a Cray-fish for a considerable time, in a shallow glass vessel, about twenty inches in diameter, and containing about two inches' depth of water. This animal gradually acquired great viciousness, and would eagerly attack the fingers of any one who chose to put them within his range, pursuing the intruding digits round the boundaries of his demesne. After he had been thus a year in my possession, I was one day surprised to see a second Cray-fish in the vessel; but on taking the intruder in my hand (believing it to have been placed in the vessel by a waggish relative), it proved to be the exuviæ of my old friend, so perfect as to present his exact counterpart. Instead of his usual boldness, he now exhibited the most remarkable timidity, which continued for three or four days. He was at first quite soft, and appeared considerably larger than usual, but gradually grew firmer, and on the fifth day felt to the touch as hard as usual, and advanced with open pincers to the attack of my finger, though evidently not without some little doubtfulness of his powers. Before the end of the week he was himself again, came on

* Histoire des Crustaces, tome ii. page 330.

† These notices of the Cray-fish are entirely extracted from Mr. Thompson's article on the Crustacea, already referred to.

more boldly than ever, and with greater effect, as his weapons were sharper. He lived nearly two years with me, and during the whole time received no food excepting one or two worms."*

The Shrimp* (*Crangon vulgaris*) is common on the sandy shores, and adjacent saline marshes, from the north to the south of Ireland. About thirty years ago, it was regularly exposed for sale at Belfast, but the side of the bay on which it was taken has now become soft and oozy, and the Shrimps so small and scarce that they are no longer sought for.†

The Prawn (*Palæmon serratus*, *Fig.* 61), so common in

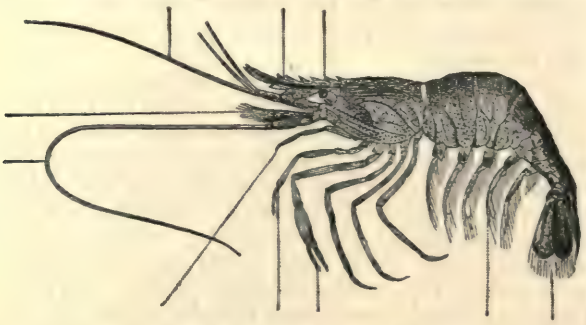


Fig. 61.—Prawn (reduced).

some of the English markets, is still taken abundantly in some localities in the south and west, but "a good dish of

* W. T.

† No apology is needed for introducing, in this place, the following beautiful passage from the writings of Archdeacon Paley.

"Walking by the sea-side, in a calm evening, upon a sandy shore, and with an ebbing tide, I have frequently remarked the appearance of a dark cloud, or rather very thick mist, hanging over the edge of the water, to the height, perhaps, of half a yard, and the breadth of two or three yards, stretching along the coast as far as the eye could reach, and always retiring with the water. When this cloud came to be examined, it proved to be nothing else than so much space filled with young 'Shrimps,' in the act of bounding into the air from the shallow margin of the water, or from the wet sand. If any motion of a minute animal could express delight, it was this:—if they had meant to make signs of their happiness, they could not have done it more intelligibly. Suppose then, what I have no doubt of, each individual of this number to be in a state of positive enjoyment, what a sum collectively, of gratification and pleasure, have we before our view!"

prawns," is a delicacy quite unknown along the north-eastern shores of Ireland.

It would be inconsistent with our limits to enter into detail respecting the smaller Crustacea, which present themselves to our notice under circumstances so varied, and at times so unexpected, that they often excite feelings of surprise, and cannot be regarded without interest.

Certain species we find in the deep water of our bays; others, like the little sand-hoppers (*Fig.* 62), on the moist margin of the strand; but there is, perhaps, no place that better repays our investigation than the beautiful little rock-pools, fringed with sea-weeds and corallines, and inhabited by multitudes of small Crustacea, which climb upon their branches, or enjoy themselves in the clear expanse of their waters. It is interesting to know the extraordinary fertility of these apparently insignificant creatures, whether living in such situations or in the ponds and ditches of our fields. "Jurine has, with great fidelity, watched the hatching and increase of one freshwater species (*Cyclops quadricornis*), and has given a calculation which shows its amazing fecundity. The female carries, on each side, a little packet of eggs, and he has seen her, when isolated, lay ten times successively; but, in order to be within bounds, he supposes her to lay eight times within three months, and each time only forty eggs. At the end of one year, this female would have been the progenitor of 4,442,189,120 young!"* This genus, from being furnished with one large compound eye, bears the classic name of Cyclops (*Fig.* 63); but its cannibalism is worse than that of the fabled



Fig. 62.—Talitrus (magnified).



Fig. 63.—Cyclops (magnified).

* Dr. Baird, in Mag. of Zoology and Botany, 1837, vol. i., page 314. See also his work entitled "The Natural History of the British Entomostraca," published by the Ray Society, 1850.—It should, perhaps, be mentioned, that the female, when once fecundated, is so for life.

giant, for the mother has been seen to devour her own young. Jurine, while he admits the fact, urges, in vindication of his little favourites, that she does not do so from choice, but that the helpless young cannot resist the action of the whirlpool the mother causes around her, and are thus carried unconsciously into the old one's mouth.

Another one-eyed Crustacean deserves mention for the exhibition it affords of one of those striking instances of providential care which the little, no less than the great, experience from the Maker of all. In drains and ditches there is found in abundance a minute creature, which, from its branching horns (*antennæ*), and its peculiar movements, is called the arborescent water-flea (*Daphnia pulex*). It looks like a small crustaceous animal enclosed in a transparent bivalve shell. The eggs are developed in the space between the body of the animal and the shell. The Daphne continues its moultings even when full grown, but perishes with the cold of winter. Ere that season, however, comes on, two eggs are produced, enclosed in a horny case, and are thrown off with the shell. These float on the water, protected from injury by their peculiar covering, and from these the numerous progeny of the ensuing summer is derived. Nor is this all; the impregnated female is not only fertile for her own life, but conveys that fertility to her female offspring for five or six successive generations, whether they be derived from the ordinary eggs or from those enveloped in the horny covering.*

It is obvious, from the particulars we have stated, that the Crustacea afford matter for curious inquiry and patient investigation, whether sought for

> "By paved fountain or by rushy brook,
> Or on the beached margin of the sea."

But it will be exhibiting them in a different light, if we mention to our readers a species that attacks the works of man, and crumbles into dust the wood-work of his piles and floodgates, piers, or jetties, constructed in salt-water. It is the *Limnoria terebrans*,† a pigmy assailant, scarcely more than

* See note in preceding page.

† Kirby and Spence's Entomology, vol. i.; W. Thompson, in Edinburgh New Phil. Journal, January, 1835. Another species, *Chelura terebrans* has been recorded as native by Dr. Allmann, in Annals of Nat. Hist. June, 1847; and some further particulars are given by Mr. Thompson in the same periodical for Sept. 1847.

the one-eighth of an inch in size, but whose destructive powers have been manifested on many parts both of the British and Irish shores.

Some of the Crustacea possess luminous powers, and together with the minute Medusæ formerly mentioned (page 41), give to the sea the splendid phosphorescence described by mariners.

There is a singular race, which we have not yet mentioned —those which infest the skin, the eyes, and the gills of fishes, and other marine animals (*Fig.* 64). Like the Entozoa, they are parasites; but from they situation they occupy, not *in* but *upon* other animals, they are spoken of by some naturalists under the name Epizoa. They are crustaceous animals, undergoing transformations, and ere the brief period of their locomotive state is ended, selecting the situation to which they afterwards adhere. Each species is known as the parasite, not only of some one particular animal, but also of some one particular organ. Hence their number is perhaps greater than that of the whole class of fishes. The sexes are distinct, "The male appears always to retain his freedom, and is singularly smaller than the female, generally not more than a fifth part of her size."*



Fig. 64.—Lernæa (magnified).

We shall close this brief notice of the structure, classification, and habits of the Crustacea, by an extract from the Zoological Researches of Mr. J. V. Thompson. It occurs in his description of the opossum shrimp, a species found in "countless myriads" on some parts of our coast, and so named from a singular pouch, analogous to that of the opossum, in which the young are carried about. The spirit of this remark is, however, applicable to a wide range of objects.

"It is in looking closely into the structure of these little animals, that we see the PERFECTION of the Divine Artist. Nature's greater productions appear coarse, indeed, to these elaborate and highly-finished master-pieces; and in going higher and higher with our magnifiers, we still continue to bring new parts and touches into view. If, for instance, we

* Owen's Lectures, page 149, &c.

observe one of their members with the naked eye—which may be the utmost stretch of unassisted vision—with the microscope it first appears jointed, or composed of several pieces articulated together; employing a higher magnifier, it appears fringed with long hairs, which, on further scrutiny, gain a sensible diameter, and seem to be themselves fringed with hairs still more minute; many of these minute parts are evidently jointed and perform sensible motions; but what idea can we form of the various muscles which put all these parts in movement, of the nerves which actuate them, and the vessels which supply them with the nutriment essential to their growth and daily expenditure, all of which we know from analogy they must possess?"

Class IV.—INSECTA—INSECTS.

"The insect youth are on the wing,
Eager to taste the honied spring,
And float amid the liquid noon:
Some lightly o'er the current skim,
Some show their gaily-gilded trim,
Quick-glancing to the sun."—Gray.

"We now come to a class of Articulata in which," says Professor Owen, "the highest problem of animal mechanics is solved, and the entire body and its appendages can be lifted from the ground and be propelled through the air. The species which enjoy the swiftest mode of traversing space breathe the air directly; but their organs of respiration are peculiarly modified, in relation to their powers of locomotion."*



Fig. 65.—Scolopendra.

Note.—The total number of Irish insects at present known is about 3850. Vid. note by A. H. Haliday, Esq. appended to the report on the Fauna of Ireland, by William Thompson, Esq. Proceedings British Association, 1843.

* Lectures, page 192.

The body is deeply cut into segments, a peculiarity which explains the origin of the word insect.* In the lower tribes the segments of the body are numerous, and in some cases so many as sixty or eighty pairs of legs may be counted on one individual. From this circumstance the term "Myriapoda" has been applied to the Centipede (*Scolopendra, Fig.* 65), and others of similar organization (*Fig.* 37).

In the true insects, the body consists of three portions (*Fig.* 66); the head, with the "horns" or antennæ, and the organs of sensation; the thorax or chest, with the organs of

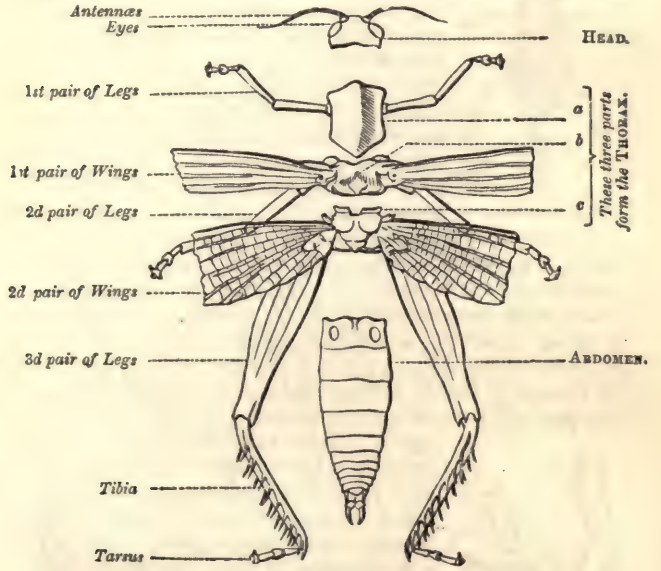


Fig. 66.—External Anatomy of an Insect.

locomotion, whether wings or legs; and the abdomen, including the organs needful for nutrition and reproduction.

The heart is an elongated muscular tube, situated along the middle of the back, and hence called the dorsal vessel. The circulating fluid is cold, transparent, and nearly colourless.† "The action of the heart is accelerated, as in other

* Latin *insectus*, cut or notched.

† Westwood, Int. to Classification of Insects, page 15, vol. i.

animals, by muscular exertion and excitement; and Mr. Newport has counted as many as one hundred and forty-two pulsations in a minute in a species of wild Bee so excited."*

Respiration is effected by means of two great canals (tracheæ) running along the sides of the body, beneath the outer surface, and communicating with the atmosphere by means of numerous short tubes, terminating at or near the sides of the body in breathing pores (spiracles); internally the tracheæ divide into innumerable branches, conveying the air to every portion of the body, and thus pervading its organs and tissues. This structure will easily be understood by referring to the accompanying figures. The Water-Scorpion (*Nepa*, *Fig.* 67) is an insect common in fresh water; and the respiratory apparatus of the same insect, as it appears when highly magnified, is shown in *Fig.* 69.



Fig. 67.—Nepa.

"There is one circumstance connected with the tracheæ which is specially deserving of admiration, whether we consider the obvious design of the contrivance, or the remarkable beauty of the structure employed. It is evident that the sides of canals so slender and delicate as the tracheæ of insects would inevitably collapse and fall together, so as to obstruct the passage of the air they are designed to convey; and the only plan which would seem calculated to obviate this would appear to be to make their walls stiff and inflexible. Inflexibility and stiffness, however, would never do in this case, where the vessels in question have to be distributed, in countless ramifications, through so many soft and distensible viscera; and the problem therefore, is, how to maintain them permanently open, in spite of external pressure, and still maintain the perfect pliancy and softness of their walls. The mode in which this is effected is as follows:—Between the two thin layers of which each air vessel consists, an elastic spiral thread (*Fig.* 68)



Fig. 68.—Air-tube of Insect.

* Owen's Lectures, page 223.

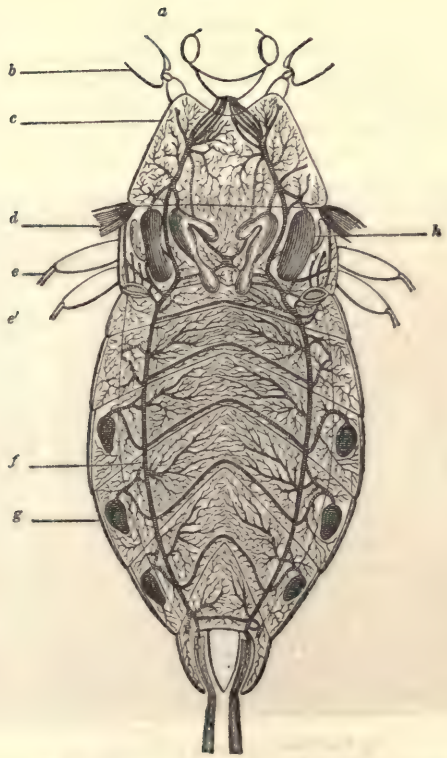


Fig. 69.—Respiratory System in Nepa (magnified).

is interposed, so as to form, by its revolutions, a firm cylinder of sufficient strength to insure the calibre of the vessel from being diminished, but not at all interfering with its flexibility or obstructing its movements; and this fibre, delicate as it is, may be traced with the microscope even through the utmost ramifications of the tracheæ, a character whereby these tubes may be readily distinguished."*

Fig. 69.—*a*, Head.—*b*, First pair of legs.—*c*, First segment of thorax.—*d*, Base of wings.—*e*, Second pair of legs.—*e'*, third pair of legs.—*f*, Tracheæ.—*g*, Stigmata or spiracles.—*h*, Air sacs.

* Outline of the Animal Kingdom, by Professor Rymer Jones, p. 266.

It is unnecessary here to dwell on the nervous system of insects; their general character is given in that of the class (page 57). In different families of insects, the ganglions, or nervous centres, whence nerves are sent to the several organs, are different in their number, and in the amount of concentration which they present (*Fig.* 70); and, as might

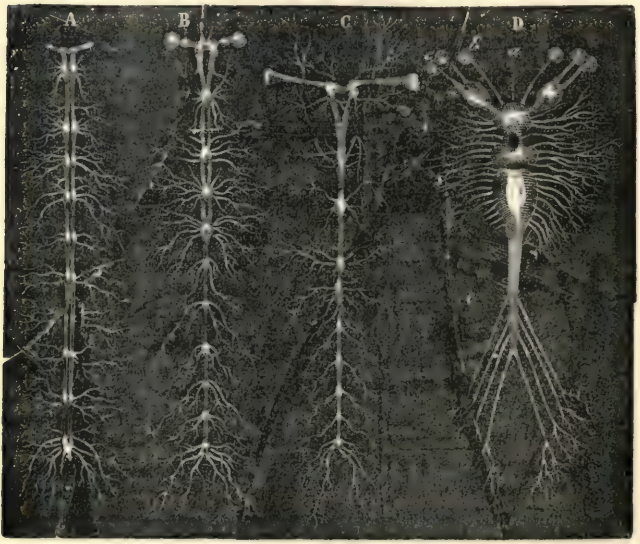


Fig. 70.—Nervous System of Insects.

naturally be expected, they undergo modifications, according to the changing form and powers of the same insect, in its different stages of development.

With regard to the external senses, insects differ from the higher animals in the possession of two processes appended to the head, and which, in the Butterfly, resemble delicate horns terminated by a knob. The entomologist* calls them *antennæ*;

Fig. 70.—A, Nervous system of an Ear-wig.—B, Of a Grasshopper.—C, Of a Stag-beetle.—D, Of a Field-bug (*Pentatoma*).—*a*, Brain.—*b*, *c*, The Optic nerves.—*d*, Thoracic ganglions.—*e*, Abdominal ganglions.

* Entomology is that department of Natural History which treats of insects.

the less scientific observers, horns, or feelers; and the latter term shows that they are applied to external objects in such a manner as to indicate that they are organs of touch. There is also reason to believe they are to some extent organs of hearing; but great doubt yet exists as to the precise extent and nature of their functions. They are very diversified in their form and structure, and vary not only in different genera, but often in the males and females of the same species.

That insects have the sense of touch and of taste, is generally conceded; and that of smell they have been supposed to possess in such perfection, that one of our most popular poets has asserted that Bees return to their hives by retracing

"The varied scents which charmed them as they flew."*

While we dissent from this poetical theory, we would by no means deny the powerful influence which certain odours exert in repelling or attracting these creatures. Of this Mr. Knapp gives an instance, in speaking of one of the Beetles, which from their habits are called "Dung-chafers." One or two only of the common Dor or blind Beetle (*Geotrupes stercorarius*) are usually seen at the same time. But, on one evening, such numbers of these insects were passing, as to constitute a little stream. This naturally excited his attention; and "I was led," he continues, "to search into the object of their direct flight, as in general it is irregular and seemingly inquisitive. I soon found that they dropped on some recent nuisance; but what powers of perception must these creatures possess, drawn from all distances and directions, by the very little fætor which in such a calm evening could be diffused around! and by what inconceivable means could odours reach this Beetle, so as to rouse so inert an insect into action! but it is appointed one of the great scavengers of the earth, and marvellously endowed with powers of sensation and means of effecting the purpose of its being."†

The sense of hearing was formerly denied to insects, even by naturalists so distinguished as Linnæus and Bonnet. Shakspeare entertained a different and more correct opinion, when he used the words,—

"I will tell it softly;
Yon Crickets shall not hear me."

* Rogers', "Pleasures of Memory."
† Journal of a Naturalist, 3d edition, page 319.

On this point the observations of Brunelli, an Italian naturalist, are quite conclusive. Several of the field Crickets which he kept in a chamber, "continued their crinking song through the whole day; but the moment they heard a knock at the door they were silent. He subsequently invented a method of imitating their sounds, and when he did so outside the door, at first a few would venture on a soft whisper, and by-and-by the whole party burst out in a chorus to answer him; but upon repeating the rap at the door, they instantly stopped again, as if alarmed. He likewise confined a male in one side of his garden, while he put a female in the other at liberty, which began to leap so soon as she heard the crink of the male, and immediately came to him—an experiment which he frequently repeated with the same result."*

There are some insects in which no organs of vision have been discovered; but in general they are not only very obvious, but present considerable variety in colour, form, position, and structure.† They are generally sessile; and when, to give them a wider range, they are fixed, like those of many crustacea, on peduncles, those stalks are not moveable. The most usual number of eyes is two; but when it is needful that the insect should, at the same time, have the power of observing objects in the air and in the water, it is gifted with four eyes, as in the common Whirl-gig (*Gyrinus natator*, *Fig.* 71), which may be seen performing its rapid evolutions on our ponds and streamlets. The eyes are sometimes simple, sometimes a number of simple eyes are collected together, and are then called conglomerate; but the most common kind is that which is termed compound. Such eyes, when seen under the microscope, appear to consist of an infinite number of convex hexagonal pieces. When separated and made clean, they are as transparent as crystal. Their number is extremely variable, and cannot but strike the most indifferent with astonishment. "What would be thought of a quadruped whose head, with the exception of the mouth and place of juncture with the neck, was covered by two enormous masses of eyes, numbering upwards of 12,000 in each mass? Yet such is the condition of the organs of vision in the Dragon-fly."

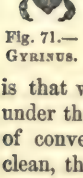


Fig. 71.—Gyrinus.

* Insect Miscellanies, page 77.

† Kirby and Spence's Introduction to Entomology, vol. iii.

In the common Bee the same structure is not less apparent. The fiery eyes of many Gad-flies (*Tabani, Fig.* 72), which present vivid bands of purple and green, are composed of similar lenses, and each eye contains nearly seven thousand.* The Ant has 50 lenses; the House-fly 4,000; while above 17,000 have been counted in the eye of a Butterfly, and more than 25,000 in that of a species of Beetle.†



Fig. 72.—Tabanus.

It is impossible to read the simple facts which science thus makes known, and not be struck with the complexity of structure shown in those diminutive creatures, considered with regard to only one of their senses and its manifold functions. Nor can we hesitate for a moment to attribute to the beneficence of our common Creator the compensating contrivances by which the want of motion



Fig. 73.—Pyralis of the Vine.

Fig. 73.—Vine-leaf attacked by the *Pyralis*.—4, The male.—4 *a*, The female.—4 *b*, The Caterpillar.—4 *c*, The eggs.—4 *d* and 4 *e*, The pupæ.

* Kirby and Spence, vol. iii. † Mordella Beetle.

in the eyes is more than counterbalanced by the abundance in which these organs are bestowed.

No one circumstance connected with insects, has perhaps arrested the attention of ordinary observers so much as what is termed their metamorphoses. The vertebrate animals retain through life, with some variations in size and colouring, very much the same forms which they had at birth. Insects, on the contrary, pass through four states of existence, and these are in general distinctly marked (*Fig.* 73). They are first contained in eggs, which are deposited by the parent in suitable situations, and with a degree of instinctive care which fills us with admiration. They then become active and rapacious, and are well known by the names of grubs, maggots, and caterpillars, according to the tribes to which they belong (*Fig.* 77). To this condition Linnæus applied the Latin word *larva* (a mask), as if the perfect insect were masked or concealed in the figure of the Caterpillar. The ravages of which the forester and the gardener complain, result most generally from the voracity of insects in their larva state. They eat much, increase rapidly in size, change their skin several times, and pass into another state, in which, in some tribes, all appearance of vitality is for a time suspended. The Caterpillar of the Butterfly or Moth, when the period for this change arrives, seeks out a secure asylum for its period of helplessness, and suspends itself by a thread (*Figs.* 74, 78), envelopes itself in silk, makes a covering of leaves, or entombs itself in the earth, according to the habits of the species. Some of them in this state appear, on a miniature scale, like Egyptian mummies, or like an infant wrapped up in swaddling-clothes. From this peculiarity the term *pupa* (a baby) has been given to them; and *chrysalis*, a word of Greek origin, referring to the bright or golden colours which some of them display, has also been applied. We shall use the terms *pupa* and *chrysalis* indifferently, meaning, in all cases, the insect in the form it has prior to its appearance in the last and perfect form;—that which is termed the Imago (*Figs.* 75, 79), as though it had not until then its perfect or fully developed image. All insects, however, do not assume the quiescent state of those just mentioned. The young of the common Gnat (*Fig.* 76) pass the early stages of their existence as inhabitants of the water, jerking about with great agility, or swimming with ease and swiftness. The Crickets and Cockroaches are as active and



Fig. 74.—Chrysalis.



Fig. 75.—Vanessa.

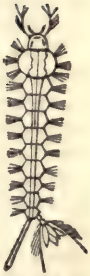


Fig. 76.—Larva of Gnat.

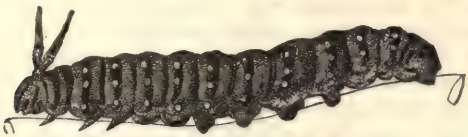


Fig. 77.—Larva of Papilio Machaon.



Fig. 78.—Pupa of Papilio Machaon.



Fig. 79.—Imago of Papilio Machaon.

lively at this period of their lives as at any other, and differ in appearance from the perfect insect only in the absence of wings.

There is something in the contemplation of these changes highly suggestive of poetic thought. The Caterpillar is seen crawling on the earth, then apparently lifeless in its self-constructed sepulchre, then flinging off the vestments of the tomb, and, with beauty of form and powers unknown before, entering on the enjoyment of a new state of existence. Hence it is not surprising that the ancients found, in its transformations, a symbol of the vague and shadowy ideas they entertained of the life of man here, of his repose in the tomb, and of the probability of a more glorious state of being hereafter. "Psyche," says an ingenious and learned writer, "means, in Greek, the human soul, and it means also a Butterfly; of which apparently strange double sense the undoubted reason is, that the Butterfly was a very ancient symbol of the soul."*

A number of terms have been employed by entomologists to denote the variety observable in insect metamorphoses: but a better acquaintance with the laws observable in the development of animals in their several stages, and a more accurate acquaintance with the functions performed by different organs and tissues in the animal frame, have stripped these changes of much of their distinctive character. Some insects are not, at any time, possessed of wings; but up to the period at which wings are developed, it is found that all insects undergo a similar series of changes. In some, however, an amount of change is undergone, before their liberation from the egg, which others do not experience until they have been some time in the enjoyment of active existence. The duration of the several progressive stages of growth differs widely in the several tribes; and this also tended to give to each an apparently distinctive character, to which it was not in reality entitled.†

With regard to their food, insects may be said to be omnivorous; for there is no animal or vegetable substance which does not form the aliment of one or more species. Some live entirely on putrifying substances, and, by thus removing them, prevent the salubrity of our atmosphere from being impaired; others are rapacious, and subsist by the destruction of those

* Nare's Essays, i. 107. Quoted by Kirby and Spence, iv. 74.
† Owen's Lectures, pages 236, 237.

that are weaker than themselves; some feed upon timber; others upon leaves and grass; some, like the "worm i' the bud," feast on our loveliest flowers; and others revel on the nectar of our choicest fruits. Some idea of the elaborate apparatus by which the food is assimilated may be formed from an examination of the digestive system in one of the carnivorous Beetles (*Fig.* 80).

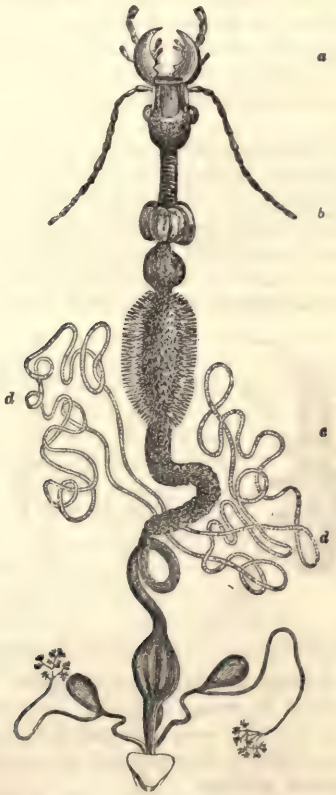


Fig. 80.—Digestive Apparatus of Beetle.

Fig. 80.—*a*, The head, with mandibles and antennæ.—*b*, The crop and gizzard.—*c*, Stomach and intestine.—*d*, Biliary vessels.

From the diversity of their food, and the great variety of circumstances under which it is obtained, we naturally expect considerable modification in the structure of the mouth and its appendages—in other words, of the instruments by which the food is obtained; and, accordingly, we find it is sometimes furnished with jaws for cutting and for masticating solids, and, at other times, with tubes of very different kinds, adapted for the imbibing of fluids, such as the blood of animals, the honey of flowers, or the sap of growing plants. Before noticing this admirable variety of structure, in connexion with the habits of different insect tribes, it may be well to acquire distinct ideas of the parts of which the mouth is composed.

The mouth of one of the rapacious Beetles (*Fig.* 81, *Carabus*), which are constantly crossing our path in quest of prey, will afford a familiar example. It consists of seven parts (*Fig.* 82). An upper lip (*labrum*); a lower lip (*labium*); a tongue (*lingua*); two upper jaws (*mandibulæ*); and two lower jaws (*maxillæ*). The motion of the jaws is not vertical, as in the vertebrate animals, but is horizontal; and the lower jaws are sometimes



Fig. 81.—Carabus.

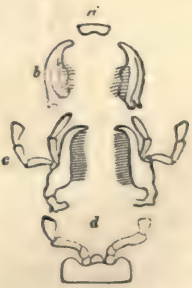


Fig. 82.—Parts of Mouth of Carabus.

employed in holding the food which the upper jaws or mandibles are engaged in cutting to pieces. In some orders the seven parts are not to be seen with such distinctness, some of them being prodigiously enlarged, and others diminished, or perhaps altogether wanting.

Fig. 82.—*a*, Labrum.—*d*, Labium.—*b*, Mandibles.—*c*, Maxillæ. The feelers attached to the Maxillæ are called *Maxillary palpi;* and those to the Labium, *Labial palpi*.

To bring this varied organism fully into play, it is necessary that each insect should possess the power of transporting itself with ease to whatever situation its necessities require, and that it should be furnished, for this purpose, with organs of flight adapted to the varying circumstances and requirements of the several tribes. These wings never exceed four in number. In beetles of burrowing habits the upper pair is hard and horny, and serves to protect the softer membranous pair when not in use. The wing-covers or shards (*elytra*) are expanded in flight, and, by their concavity, help to sustain the insect in the air; hence Shakspeare's description of

"The shard-borne beetle, with his drowsy hums,"

is not less accurate than poetical. In other tribes the wings resemble the finest lace; and in the butterflies and moths they are covered with a mealy substance, which examination under a lens shows to be composed of the most delicate scales, differing in form, in size, and in colouring, and giving to some of these "gilded butterflies" the gorgeous metallic tints for which they are so remarkable.

"The grand and characteristic endowment of an insect," says Professor Owen, "is its wings; every part of the organization is modified in subserviency to the full fruition of these instruments of motion. In no other part of the animal kingdom is the organization for flight so perfect, so apt to that end, as in the class of insects. The swallow cannot match the dragon-fly (*Fig.* 83) in flight. This insect has



Fig. 83.—Dragon-fly.

been seen to outstrip and elude its swift pursuer of the feathered class; nay, it can do more in the air than any bird; it can fly backwards and sidelong, to right or left, as well as forwards, and alter its course on the instant without turning." These "limber fans" are of use in another capacity; they take their share in the business of respiration, and hence have been termed, from analogy, "aerial gills."

From the great importance of the wings, and from the modifications in their structure, they become naturally the basis for classification; and without going much into details, we shall endeavour to denote the principal groups of insects, and notice their most striking characteristic features and habits.

NOTE.—In the brief outline, here given, we have, for the sake of simplicity, adhered to the Linnæan orders, with the additions of *Orthoptera* and *Strepsiptera*. Some of them, it may be proper to mention, have been subdivided by modern entomologists. The meaning of the compound term by which each order is designated will be given where the term occurs: but it seems desirable, at the commencement, to place before the learner, at one view, a list of all the orders hereafter mentioned, with the literal signification of the names, and some well-known example of the insects belonging to each division. Thus:—

I. Coleoptera,	sheath-winged,	beetles, &c.
II. Orthoptera,	straight-winged,	crickets, locusts, &c.
III. Neuroptera,	nerve-winged,	dragon-flies.
IV. Hymenoptera,	membrane-winged,	bees, ants, &c.
V. Strepsiptera,	twisted-winged,	stylops.
VI. Lepidoptera,	scale-winged,	butterflies, &c.
VII. Hemiptera,	half-winged,	cicadæ, water-scorpions, &c.
VIII. Diptera,	two-winged,	flies, gnats, &c.
IX. Aptera,	without wings,	fleas, spring-tails, &c.

The first of these orders *Coleoptera* (page 107) was established by Aristotle. The term is derived from two Greek words, meaning sheathed or encased wings. Of Beetles, or *Coleopterous* insects, we have about 950 Irish species, according to the catalogue mentioned at page 92, and referred to hereafter. It must be recollected that the numbers quoted at any particular time, as belonging to the different orders, should be regarded as showing the extent to which they had been investigated at that period, and not as representing either the proportion actually collected, or that probably existing.

COLEOPTERA.



Fig. 84.
PTINUS (MAGNIFIED).



Fig. 85.
MALE GLOW-WORM.



Fig. 86.
FEMALE GLOW-WORM.

Among the various tribes of beetles constituting the present order, very great difference exists even in our native species, in size and colouring. The great water-beetle (*Dytiscus marginalis*) is sufficiently powerful to play the tyrant of the pool in which he lives, and even to attack and overcome small fishes. Others, again, are so minute, as to live in the perforations they make in the timber of our dwelling-houses, and thus to escape detection by ordinary observers.* Among the latter may be mentioned those little beetles (*Fig.* 84), to which vulgar superstition has given the name of "Death-watch."

"The solemn Death-watch click'd the hour she died."—GAY.

This sound, which is only the call of the insect to its companion, has caused many a heart to throb with idle fears, which a slight knowledge of natural history would for ever have dispelled. It so exactly resembles the ticking of a watch, that Mr. R. Ball, by placing his watch to the wainscot which the little beetle frequented, has caused the insect to respond to its ticking.

The structure of the mouth and of the wings has already

* Mr. Spence has given an interesting account of the destruction of large beams of timber in the dwelling-houses at Brussels, by one of those insects. "The mischief," he says, "is wholly caused by *Anobium tessellatum* which thus annually puts the good citizens of Brussels to an expense of several thousand pounds, much of which might have possibly been always saved, had the real cause of the evil been known."—Transactions of the Entomological Society, vol. ii. page 11.

been mentioned, but it must be understood that in both there are considerable modifications. In many beetles, the wing-cases, or, to use the more correct term, the elytra, are united together, and, as wings could not be used, they are not given. In the glow-worm (*Fig.* 85, 86), an insect we do not possess in Ireland,* the female, being soft and wingless, does not seem to belong to the present order; but the male is possessed of elytra, and of expansive wings, by means of which he is enabled to shape his course to the "nuptial lamp" displayed by the more stationary female. This idea, though apparently fanciful, appears to be borne out by experiment.†

The "droning-flight" of the Dor-beetle, heard in the twilight of the summer-evening's walk, is a sound with which every one is familiar; and equally well known is the manner in which the creature startles us from our reveries by striking against our faces. It is from this circumstance, and not from any absence of the sense of vision, that its common epithet, the "blind-beetle," has been derived. Both peculiarities have been noticed by Collins in his "Ode to Evening":—

"Now air is hushed, save
Where the beetle winds
His small but sullen horn;
As oft he rises, 'midst the twilight path,
Against the pilgrim borne in heedless hum."

This common insect affords an example of the manner in which many animals feign death, in order to deceive their enemies. If taken in the hand, and tossed about, its legs will be set out perfectly stiff and immoveable (which is its posture when really dead), and will so continue until allowed to remain for a minute or two undisturbed. If the hand be closed, its strength is such, that it is difficult, by the strongest pressure we can exert, to prevent its escape.

To this family belongs the sacred beetle of the Egyptians (*Fig.* 87), whose image remains sculptured on many of their

* The luminous worm found on some of the bogs in Ireland (ante, page 67), is not an *insect*, but a species of *annelid*.

† Vide Entomologia Edinensis, page 206. The idea has been embodied by Moore:—

——"beautiful as is the light
The glow-worm hangs out to allure
Her mate to her green bower at night."

obelisks and other monuments. Denon,* in his splendid work on Egypt, states that it was an emblem of wisdom, strength, and industry, and that it occupies the most distinguished place in the temples, not merely as an ornament, but as an object of worship. Among the Egyptian antiquities preserved in the British Museum, is a colossal figure of this insect, placed upon an altar, before which a priest is kneeling. Similar figures of the insect, but of a small size, are frequently found on the breasts of mummies, and were probably worn as amulets.



Fig. 87.—Sacred Beetle of the Egyptians.

All Egyptian travellers speak with surprise of the habits of this beetle, in collecting and rolling about a ball of dung, in which it deposits an egg. A similar custom prevails in one of our native species (*Geotrupes vernalis*); but in districts where sheep are kept, it wisely saves its labour, and ingeniously avails itself of the pellet-shaped balls of dung which these animals supply, and which are admirably adapted for its purpose.†

Among the beetle tribes are some which are cased in armour of brilliant metallic lustre, and there are species found on vegetables which are splendid objects when their beauties are revealed by the microscope. There is one which, though taken in many parts of Ireland, has not as yet been observed in the northern districts, and which is remarkable both for its beauty and its activity (*Cicindela campestris*). Its colour is a golden green, with white or yellow spots, and appears particularly rich when the insect is running rapidly along in the bright sunshine of a summer's day. It is one of a family, justly named by Linnæus the tigers of the insect tribes. "Though decorated with brilliant colours, they prey upon the whole insect race; their formidable jaws, which cross each other, are armed with fearful fangs, showing to what use they are applicable; and the extreme velocity with

* Vol. ii. page 60.

† Sturm, quoted by Kirby and Spence, vol. ii. page 475.

which they can either run or fly, renders hopeless any attempt to elude their pursuit"* (*Fig.* 88). In contrast with these carnivorous Beetles, we may mention some whose powers are exercised on vegetable matter. The best known of these is perhaps the common Cockchafer (*Melolontha vulgaris*), an insect extremely abundant in England, but in the North of Ireland of comparative scarcity. It spends three years in the ground feeding on the roots of grass and other vegetables. In its mature state its attacks are openly made on the leaves of our hedge roses and forest trees. There are others who carry on their proceedings so as to elude our observation. Thus:—

> ——"The red-capp'd worm, that's shut
> Within the concave of a nut,"

is the larva of a Weevil. The mother is furnished with a long horny beak (*Fig.* 89), and while the nut is yet soft, she



Fig. 88.—CICINDELA.



Fig. 89.—NUT WEEVIL (MAGNIFIED).

drills a hole through the shell, deposits an egg, and thus furnishes her future offspring with a house for its defence and food for its support.

Much more laborious is the process by which the burying Beetles (*Fig.* 90) attain the same object. With united industry they excavate the earth from under the dead body of a frog, a bird, or other small animal, until at length it is interred to the depth of some inches, and covered

* Kirby and Spence, vol. i. page 268.

over with earth. The eggs are deposited in the decaying flesh, and thus the young grubs, when hatched, find themselves surrounded by a store of food provided by the instinctive labours of the parents.



Fig. 90.
Burying Beetle.

We have spoken of the coleopterous insects more fully than we shall of those belonging to some of the other orders; but not more fully than their variety and importance deserve. Mr. Westwood states, that the number of species of this order, with which entomologists are acquainted, cannot be less than 35,000; and he thinks it more than probable, that when those from foreign countries shall have been collected, the number will be doubled, if not trebled. The Berlin museum alone contains 28,000 species.

DIFFERENT STATES OF A GRANIVOROUS BEETLE (CALOSOMA).



Fig. 91.—
Larva.



Fig. 92.—
Imago.



Fig. 93.—
Pupa.

ORTHOPTERA.*



Fig. 94.—Phyllium Siccifolium.

This division includes in it the Cockroaches, Crickets, Grasshoppers, and Locusts, and those singular-looking creatures, from tropical countries, which have been, by common consent, named "walking-sticks" and "leaf insects." Some of the latter, which we see in our museums, have the wing-covers of so bright and fresh a green, that we can with difficulty persuade ourselves we are looking on an insect; while others present a no less striking resemblance to the colour of the leaf, and its delicate reticulations, as it lies on the ground in its withered state (*Fig.* 94).

Another foreign insect deserves mention, because it has

* Derived from two Greek words; one signifying *straight*, the other a *wing;* the arms being longitudinally folded when at rest. About fifty Irish species.

obtained from its attitude the appellation of the "praying Mantis" (*Fig.* 95); and popular credulity, both in Europe and Africa, has gone so far as to assert, that a child or a traveller, who has lost his way, would be guided by taking one of these pious insects in his hand, and observing in what direction it pointed. They have the character of being gentle, while in

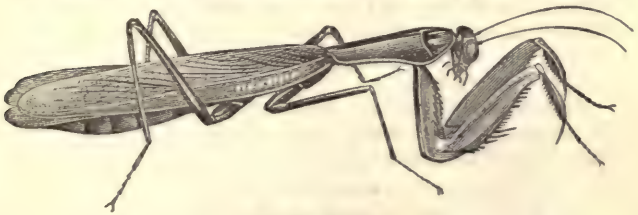


Fig. 95.—Mantis.

reality they are extremely ferocious. Using one of the fore-legs as a sabre, they can cut off the head of an antagonist at a single stroke, and are so pugnacious, that the Chinese children, according to Barrow, sell to their comrades bamboo cages, each containing a Mantis, which are put together to fight.*

Insects of this order have jaws no less powerful than those of the Beetle tribes, and which are well fitted for acting upon the vegetables that form their principal food. Their wings are different from those of the Coleoptera, the wing-covers being less opaque, and bearing some resemblance to parchment, while the wings themselves are folded, when not in use, in a different manner.



Fig. 96.—House-cricket.

Perhaps in these countries no individual of the order is so well known as the House-cricket (*Fig.* 96), which common

* Kirby and Spence, vol. i. page 275. Westwood, vol. i. page 427.

belief regards as foretelling cheerfulness and plenty. The more just exposition would be, that as crickets revel on the yeast, the crumbs, the milk, the gravy, and all the waste and refuse of a fireside, their presence does not prognosticate that plenty is to come, but that it already exists. In like manner, when they gnaw holes in clothes which are drying at the fire, the naturalist would say, that the action is not done, as is commonly said, because of injuries they have received, but simply because the moisture which the clothes contain is gratifying to their thirsty palates.

Shakspeare, Milton, and many other poets, have noticed the chirp of "the Cricket on the Hearth," but none have offered to it a more graceful tribute than Cowper:—

> "Thou surpasseth, happier far,
> Happiest grasshoppers that are;
> Theirs is but a summer's song,
> Thine endures the winter long,
> Unimpair'd, and shrill and clear
> Melody throughout the year."

The Rev. Gilbert White, in that charming "Natural History of Selborne," which it seems scarcely possible to quote without commendation, devotes a letter to a graphic and interesting account of the habits of the Field-cricket (*Acheta campestris*). In this he justly remarks, that "sounds do not always give us pleasure according to their sweetness and melody, nor do harsh sounds always displease. Thus the shrilling of the Field-cricket, though sharp and stridulous, yet marvellously delights some hearers, filling their minds with a train of summer ideas, of everything that is rural, verdurous, and joyous."

The Cockroaches (*Fig.* 97), which also belong to the present order, are regarded with feelings very different from those associated with the crickets. They devour bread, meat, cheese, woollen clothes, and even shoes. On board ship, barrels of rice, corn, and other provisions, are at times completely destroyed by them. In some tropical countries, they swarm by myriads in old houses, making every part filthy beyond description. They sometimes attack sleeping persons, and will even eat the extremities of the dead.*

There is another insect belonging to the present order, whose very name is associated, not with disgust, but with

* Westwood, vol. i. page 418.

terror: we allude to the Locust (*Fig.* 98). In these countries we are happily exempt from its devastations; but a few detached individuals are occasionally wafted hither, and, in this way, so many as twenty-three species are now recorded as British. For some account of the ravages which they have at various times committed, we refer to Kirby and Spence's Introduction to Entomology, vol. i. page 212, where much information on the subject has been carefully brought together. The description given by the Prophet Joel is not less remarkable for its fidelity than its grandeur. "A fire devoureth before them, and behind them a flame burneth: the land is as the Garden of Eden before them, and behind them a desolate wilderness; yea, and nothing shall escape them. Like the noise of chariots on the tops of mountains shall they leap, like the noise of a flame of fire that devoureth the stubble, as a strong people set in battle array."



Fig. 97.—Cockroach.



Fig. 98.—Locust.

NEUROPTERA.*



Fig. 99.—Indian Libellula, or Dragon-fly.

This order of insects includes the Dragon-flies, the May-flies, the Lacewinged-flies, the Ephemera, and the destructive Termites, or white ants. They have four large-sized wings, equal in size, furnished with numerous nervures, and presenting, in some species, an appearance of the most delicate network. The jaws are fitted for mastication.

No one who looks upon any of our native Dragon-flies (*Libellulæ*, *Fig.* 86) hawking over a pond on a bright summer day, and marks the facility with which their insect prey is taken and devoured, could ever suppose that these swift-flying creatures had but a few weeks before been inhabitants of the water. Yet it is there the early stages of their life are passed. The female has been observed to descend the leaf or stem of an aquatic plant to deposit her eggs. The larva, when excluded, is not less ferocious than the perfect insect, and is furnished with a singular apparatus, a kind of mask, which is used not only for seizing its prey, but for holding it while the jaws perform their customary office.† On one occasion we lifted one of these larvæ, when feeding on a

* From two Greek words, one signifying a *nerve*, the other a *wing*. The term "*nerves*" is commonly applied to the *nervures* or minute tubes by which the wings are expanded. The order contains about seventy Irish species.

† For a lucid description of this instrument, see Kirby and Spence, vol. iii. page 125.

Tadpole, but it continued its repast without evincing the slightest discomposure. When the time for deserting the water has arrived, it climbs upon the stem or leaf of one of the water-plants, emerges from its pupa case, and, after resting until its wings are expanded and dried, enters, in the air upon a course of the same ceasless rapacity which it had waged while in the water.

Some have the wings expanded horizontally when at rest (*Figs.* 83, 99); others have them closed and erect (*Fig.* 100);



Fig. 100.—Agrion

but in both, the movements of the insects are so light and graceful, their colours so splendid, and, at the same time, so varied, displaying the softest green and the richest azure, that our neighbours, the French, have bestowed on them the appellation of "demoiselles;" and one of our poets has applied to them a corresponding term.

> "Chasing, with eager hands and eyes,
> The beautiful blue *damsel* flies,
> That fluttered round the jasmine stems
> Like winged flowers or flying gems."—Moore.

The insects to which anglers give the name of May-flies (*Phryganeæ, Fig.* 101) also pass the beginning of their



Fig. 101.—Phryganea.

existence in the water. Mr. Hyndman, of Belfast, noticed, some years ago, the proceedings of the female in one of the ponds in the Botanic Garden, near that town, and favoured us with the following note:—"I first observed the Phryganea on the leaf of an aquatic plant, from which it crept down along the stem under the water, very nearly a foot deep; it appeared then to have been disturbed by some stickle-backs, which approached and seemed inclined to attack it, and swam vigorously and rapidly beneath the water, over to some other plants. I there took the insect up, and found a large bundle of eggs, of a green colour, closely enveloped in a strong jelly-like substance, attached to the extremity of its abdomen."

The larvæ of these flies, well known under the name of Case-worms, or Caddis-worms (*Fig.* 102), are to be found in



Fig. 102.—Caddis-worms.

every running stream, and almost in every ditch. Their habitations are extremely singular, and differ considerably, both in the materials employed and in their external configuration. Some are formed of numerous little pieces of grass and stems of aquatic plants cut into suitable lengths and placed crossways, forming a rude polygonal figure; others are constructed of bits of stick, or grains of sand and gravel, cemented together; and others, again, are composed of fresh-water shells, each containing its own proper inhabitant, "a covering," as Kirby and Spence remark, "as singular as if a savage, instead of clothing himself with squirrel-skins, should sew together into a coat the animals themselves." But, whatever may be the material employed, the little builders contrive to make them of nearly the same specific gravity as the water, so as to be carried without labour. When about to assume the pupa state, they construct a kind of grating at each extremity of the case, and thus provide, at the same time, for respiration and defence.

Similar cases encrusted with carbonate of lime are found in Auvergne, in France, forming strata six feet in thickness, and extending over a considerable area.*



Fig. 103.—Ephemera.

The Ephemera (*Fig.* 103), whose brief period of existence in its perfect state has become proverbial, belongs also to this division. He who reads Dr. Franklin's charming paper† containing the soliloquy of an aged Ephemera, who had lived "no less than four hundred and twenty minutes," will ever afterwards look with interest upon the insect which has been made the means of conveying a lesson so true and so comprehensive.

HYMENOPTERA.‡



Fig. 104.—Tenthredo.



Fig. 105.—Ichneumon.

The insects of this order have four veined membranous wings, but they are not equal in size, nor are they reticulated,

* Lyell. Principles of Geology, vol. iv. page 165.

† The Ephemera, an Emblem of Human Life.

‡ From two Greek words; one signifying a *membrane*, the other a *wing*, all the four wings being membranous. About 1100 Irish species.

as in the preceding order. The female is furnished either with a sting at the extremity of the abdomen, or with an instrument termed an ovipositor (*Fig.* 107), used in the deposition of the eggs. The jaws are powerful, and the tongue, instead of being small and inconspicuous, becomes in some tribes an organ of great size and importance. To this order belong the Saw-flies, Gall-flies, Ants, Wasps, and Bees, insects which have in all ages attracted attention, and among which the power of instinct, in directing the actions of populous communities, is displayed in its highest perfection.

The Saw-flies (*Tenthredinidæ*, *Fig.* 104) take their name from a pair of saw-like instruments, with which the female is furnished, and which she employs for making an incision, in which she deposits an egg. The turnip, the rose, the apple, and the willow, suffer from insects of this tribe. But the species best known in these countries, is perhaps that whose larvæ attack the gooseberry (*Nematus grossulariæ*). From fifty to more than a thousand are sometimes observed upon a single tree, of which they devour all the leaves at the beginning of summer, so that the fruit cannot ripen. There are two generations in the course of a year.* An allied species attacks the red currant; but we have been informed that it sedulously avoids the black currant, and in the course of its defoliating progress leaves it quite untouched.

The Gall-flies (*Cynipidæ*, *Fig.* 106) are those which puncture plants, and, in the wound thus made, insert one of their eggs along with an irritating fluid, the action of which upon the plant produces tumours or galls of various sizes, shapes, and colours. That found on the wild rose, and called the beguar or bedeguar of the rose, is well known. The galls which come to us from the Levant, and which are of so much importance for the manufacture of writing-ink and of black dyes, are about the size of a boy's marble, and each contains only one inhabitant; others support a number of individuals. Mr. Westwood procured so large a number as 1100 from one large gall found at the root of an oak.



Fig. 106.—Cynips.

* Westwood's Introduction, vol. ii. page 103.

The celebrated Dead Sea apples, described by Strabo, the existence of which was denied by some authors, have recently had their true nature ascertained. They are galls, not fruit, of a dark reddish purple colour, and about the shape and size of small figs. The inside is full of a snuff-coloured, spongy substance, crumbling into dust when crushed; and this furnishes the guides with an opportunity of playing "tricks upon travellers." "The Arabs," says Mr. Elliott, "told us to bite it, and laughed when they saw our mouths full of dry dust."* Moore has very felicitously referred, in his *Lalla Rookh*, to those

> ——"Dead Sea fruits that tempt the eye,
> But turn to ashes on the lips."

In the next division (*Ichneumonidæ*, *Figs.* 105, 107) we find the insects depositing their eggs, not on the leaf or stem of a tree, but actually in the body of a living caterpillar. Because of their services in thus preventing the too great multiplication of insects, Linnæus gave to them the name Ichneumon, thus indicating an analogy in their habits to those formerly attributed to the quadruped of that name, as the destroyer of the crocodile. About three thousand species of Ichneumons are at present known and described. "They all deposit in living insects, chiefly while in the larva state, sometimes while pupæ, and even while in the egg state, but not, as far as is known, in perfect insects. The eggs thus deposited soon hatch into grubs, which immediately attack their victim, and in the end ensure its destruction. The number of eggs committed to each individual varies according to its size, and that of the grubs which are to spring from them, being in most cases one only, but in others amounting to some hundreds."†

In order to convey an idea of the services rendered by these insects, Kirby and Spence inform us, "that out of thirty individuals of the common cabbage caterpillar, which Réaumur put in a glass to feed, twenty-five were fatally pierced by an Ichneumon; and if we compare the myriads of caterpillars that often attack our cabbages and brocoli with the small number of butterflies of this species which usually appear, we

* Trans. Entomological Society, vol. ii. page 14.
† Intr. to Entomology, vol. i. page 264.

may conjecture that they are commonly destroyed in some such proportion—a circumstance which will lead us thankfully to acknowledge the goodness of Providence, which, by providing such a check, has prevented the utter destruction of the Brassica genus, including some of our most esteemed and useful vegetables."*

It is worthy of remark that the caterpillar thus attacked continues to eat and apparently to enjoy life as usual. The larva placed within it avoids the vital parts, until the period for its own liberation or change of state has arrived; and it has been ascertained that many of these larvæ are, in like manner, preyed upon by Ichneumons still more minute than themselves.



Fig. 107.— ICHNEUMON.§

"The development of these parasites within the bodies of other insects was, for a long time, a source of much speculation amongst the earlier philosophers, who conceived it possible that one animal had occasionally the power of being absolutely transformed into another. Thus, Swammerdam records, as 'a thing very wonderful,' that 545 flies of the same species were produced from four chrysalides of a butterfly, 'so that the life and motion of these seem to have *transmigrated* into that of 545 others.'† How much greater would have been the astonishment of this ardent and laborious naturalist, could he have seen 20,000 of these minute Ichneumons issue from the chrysalis of a goat-moth, a number which one author regards as a 'moderate computation!'"‡

* Intr. to Entomology, vol. i. page 266. All the varieties of the turnip and cabbage belong to the genus *Brassica*.

† Westwood, vol. ii. page 145.

‡ Moses Harris. Vid. Westwood, vol. ii. page 9.

§ The three thread-like appendages at the extremity of the abdomen, in figure 107, consist of the ovipositor, and two filaments between which it lies, as in a sheath, when not in use.

We now enter upon the examination of those insect tribes which congregate into large and well-regulated communities, and in which new powers and instincts are developed. Among these are the Ants, in which we mark, with wonder and admiration,

> ——"The intelligence that makes
> The tiny creatures strong by social league,
> Supports the generations, multiplies
> Their tribes, till we behold a spacious plain,
> Or grassy bottom, all with little hills,
> Their labour, cover'd as a lake with waves;
> Thousands of cities in the desert place
> Built up of life, and food, and means of life!"
>
> WORDSWORTH.

It may seem strange that the little, busy, wingless creatures, that we see foraging about our fields and gardens, with ceaseless activity, should be mentioned among insects having four membranous wings. But, if an ant's nest be examined towards the end of summer, numbers of them will then be found possessed of these appendages. They are young Ants, just liberated from the cocoon. The males and females rise together into the air; the males soon perish: some of the females return to their original home, and others, casting their wings aside, become the solitary founders of industrious and populous cities. On the neuters devolve the erection of the store-houses, the making of the highways, the nursing of the young grubs, the catering for all, and many other offices essential to the well-being of the community. For an account of their labours, their sports, their wars, their ingenious devices, their slave-taking expeditions, and their modes of communicating information, we refer to Kirby and Spence's delightful Introduction to Entomology, in which the most interesting observations of Gould, Huber, and many other naturalists, have been embodied.

The celebrated honey-dew of the poets is now found to be a saccharine secretion, deposited by many species of aphides or plant-lice. Of this the ants are passionately fond, not only sucking it with avidity whenever it can be obtained, but, in some cases, shutting up the aphides in apartments constructed specially for the purpose, and tending them with as much assiduity as we would bestow on our milch cattle.* It is a

* Kirby and Spence, vol. ii. page 90.

singular circumstance, and one that shows how infinite is the wisdom with which all these things are ordered, that the aphides become torpid, and remain so during the winter, at the same degree of cold that induces torpidity in the ants themselves.

The fact, now ascertained, that our ants pass the winter in a torpid state, is contrary to popular belief. The prevailing notion is, that during the summer and autumn, they sedulously lay up a stock of provision for the winter, one end of each grain being carefully bitten off, in order to prevent germination. This idea, current but erroneous, is embodied in the following extract from Prior:—

——"Tell me, why the ant,
In summer's plenty, thinks of winter's want?
By constant journey, careful to prepare
Her stores, and bringing home the corny ears—
By what instruction does she bite the grain?
Lest, hid in earth, and taking root again,
It might elude the foresight of her care."

In this, and many other examples which might be quoted, the poet gives utterance to the fallacious but prevailing opinion of his time. The error, in this instance, had probably arisen from the ants having been observed carrying their young about in the state of pupæ, at which time, both in size and shape, they bear some resemblance to a grain of corn; and it would receive confirmation from their being occasionally seen gnawing at the end of one of these little oblong bodies—not to extract the substance of the grain, or to prevent its future germination, but in reality to liberate the enclosed insect from its confinement.

The fact that no European species of Ant stores up grain, no way affects the lesson which Solomon so beautifully inculcates:—"Go to the ant, thou sluggard; consider her ways and be wise; which having no guide, overseer, or ruler, provideth her meat in the summer, and gathereth her food in the harvest."* Even if the insect did not collect a supply of food for future use, we might all, with great advantage, "consider her ways and be wise." But it is more than probable that Solomon referred to species living in a warmer climate, and,

* Proverbs, chap. iv. ver. 6, 7.

consequently, different in modes of life from those which are indigenous here. This view is corroborated by the discovery made by Colonel Sykes, of a species* living in India, which hoards up in its cell the seeds of grass, and takes the precaution of bringing them up to the surface to dry, when wetted by the heavy rains peculiar to the country.

We pass on to a tribe of Hymenopterous insects with which the generality of observers have but little sympathy—the Wasps. Their community consists of males, females, and neuters. At the commencement of spring, an impregnated female, who has survived the winter, commences the foundation of a colony, which, ere the end of summer, may contain twenty or thirty thousand individuals. The neuters are soon brought forth, and set themselves sedulously to their task of forming cells, collecting food, and attending to the young brood. It is while they are engaged in these labours that we find them so intrusive and troublesome.

The males and females are produced only towards autumn; the males and neuters die as the season advances, and each of the widowed females who survives comes forth in spring an isolated being, to establish another city not less populous than that which has perished. The singular treatment the young grubs receive appears to us, at first sight, unnatural and even revolting. On the approach of cold weather, they are dragged from their nests, and rigorously put to death by the old Wasps, who, until then, had laboured so assiduously for their support and protection.

It is a singular fact, that the nests of these insects are made of a material which we are apt to regard as a modern invention—paper. With their strong mandibles they cut or tear off portions of woody fibre, reduce it to a pulp, and, of the *papier maché* thus fabricated, the cells, and often the covering of their habitations, are formed. The exterior of the tree-nests of some of the foreign species is perfectly white, smooth, and compact, resembling in appearance the finest pasteboard. The nest of our common Wasp is less attractive; but when it has been carefully dug out of the earth, and the interior laid open to view, with its successive layers of symmetrical cells skilfully supported upon ranges of suitable pillars, the regularity and perfection it displays cannot

* *Atta providens.* Trans. Entomological Society, vol. i. page 103.

be contemplated without feelings of surprise and admiration (*Fig.* 108).

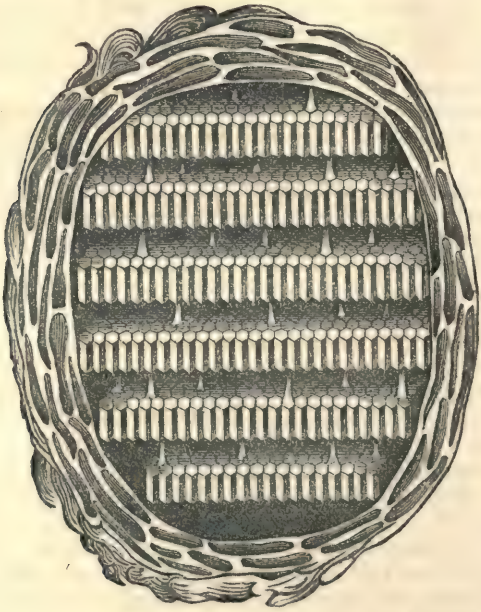


Fig. 108.—Interior of Wasp's Nest.

Besides the social Wasps, there are tribes which have obtained the name of "Sand-wasps." These consist only of males and females, which form their habitations in the crevices of old walls, or excavate them in wooden palings, in sand-banks, or similar situations. The female does not limit her maternal care to the placing of her eggs in safe and suitable situations; but with provident anxiety she collects a supply of food sufficient for the sustenance of the young grub. The food consists of other insects, larvæ and spiders; and, this being provided, the entrance is carefully closed up.*

The Bee, "that at her flowery work doth sing," is so associated with pleasurable ideas of sunshine and flowers, of

* Westwood, vol. ii.—Kirby and Spence, vols. i. and ii.

industry and happiness, that all have felt what Archdeacon Paley has well expressed, "a Bee amongst the flowers in spring is one of the cheerfullest objects that can be looked upon. Its life appears to be all enjoyment; so busy and so pleased."

Bees may, like Wasps, be divided into the solitary and the social. Some of the solitary Bees, like the solitary Wasps, construct their cells in a cylindrical hole, scooped out of a dry bank; or in one of the vacant spaces of a stone wall. Others select the hollows of old trees, and have occasionally been found in the inside of the lock of a garden gate, taking the precaution, however, to cover their nests with the woolly portions of certain plants, and thus to secure for their young, a more equable temperature.* A third group has been termed Carpenter Bees, as wood forms the material in which they excavate their nests. Among these, the female of one of our native species "chooses a branch of brier or bramble, in the pith of which she excavates a canal about a foot long, and one line,† or sometimes more, in diameter, with from eight to twelve cells, separated from each other by partitions of particles of pith glued together." But perhaps the most remarkable insect of the group is the *Xylocopa* (*Figs.* 109, 110), a large species belonging to southern Europe, and having wings of a beautiful violet colour. In the decaying espaliers, or other wood-work, she hollows out a tunnel of twelve or fifteen inches, which she divides into ten or twelve distinct apartments, in each of which she deposits an egg and a quantity of honey and pollen, for the support of the future grub.

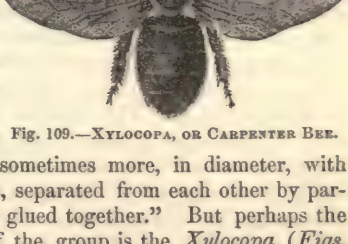


Fig. 109.—Xylocopa, or Carpenter Bee.

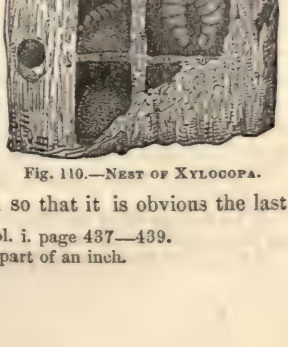


Fig. 110.—Nest of Xylocopa.

This must be a work of time, so that it is obvious the last

* Kirby and Spence, vol. i. page 437—439.

† A line is the twelfth part of an inch.

egg in the last cell must be laid many days after the first; and, consequently, the egg in the first cell must have changed into a grub, and then into a proper Bee, many days before the last. What, then, becomes of it? It is impossible that it should make its escape through eleven superincumbent cells without destroying the immature tenants; and it seems equally impossible that it should remain patiently in confinement until they are all disclosed. This dilemma our heaven-taught architect has provided against. With forethought never enough to be admired, she has not constructed her tunnel with one opening only, but at the farther end has pierced *another* orifice, a kind of back-door, through which the insects produced by the first-laid eggs successively emerge into day. In fact, all the young Bees, even the uppermost, go out by this road; for, by an exquisite instinct, each grub, when about to become a pupa, places itself in its cell with its head downwards, and thus is necessitated, when arrived at its last state, to pierce its cell in this direction."*

Another group of artisan Bees carry on the business, not of carpenters, but of masons, building their solid houses solely of artificial stone. This material is formed of particles of sand, agglutinated together, and the mansion is generally erected in some eligible site, sheltered by a projection, and facing the south. But there are others still more luxurious, who hang the interior of their dwellings with a tapestry of leaves or flowers. These are the upholsterers; among them is "a species (*Apis papaveris*), whose manners have been admirably described by Reaumur. This little Bee, as though fascinated with the colour most attractive to our eyes, invariably chooses for the hangings of her apartments the most brilliant scarlet, selecting for its material the petals of the wild poppy, which she dexterously cuts into the proper form."† The bottom of the chamber she has excavated is rendered warm by three or four coats, and the sides have never less than two. Other native species of the same family are content with more sober colours, generally selecting for their tapestry the leaves of trees, and especially those of the rose; whence they have obtained the name of *leaf-cutter* Bees.

The social Bees have, in each community, three kinds of

* Taken from Kirby and Spence, vol. i. page 440, who give the facts on the authority of Réaumur.

† Kirby and Spence, vol. i, pages 443, 444.

individuals—males, females, and workers or neuters; and, among other peculiarities, they are distinguished from the solitary species by the secretion of the wax of which the cells are constructed. The humble Bees, composing the genus Bombus (*Fig.* 111), are known by their large size and hairy



Fig. 111.—Bombus or Humble Bee.

bodies, often of a black colour with orange bands. "They form societies consisting of about fifty or sixty individuals, occasionally, however, amounting to two or three hundred. They construct their dwellings under ground, in meadows, pastures, or hedge-rows, generally employing moss for this purpose. Their union, however, lasts only till the cold weather kills the great mass of the inhabitants, a few impregnated females alone surviving, to become the foundresses of fresh colonies at the commencement of the following spring."*

The Hive-bee is, however, the species to which above all others our interest attaches; and it is curious that much of our knowledge of the habits and economy of these insects is derived from the labours of a blind man. The elder Huber lost his sight at the early age of seventeen; but, by means of glass hives variously constructed, he was able to exhibit to his wife all that was going on within them, and by her faithful recital of what she witnessed, and the aid of an untiring investigator, M. Burnens, he amassed the material for his celebrated work. Among the ancients, Aristotle, Pliny, and Virgil have recorded their observations upon Bees; in modern times, Swammerdam, Reaumur, Latreille, Bonnet, and some

* Westwood, page 280.

distinguished British naturalists, have contributed much that is valuable; yet the subject is still unexhausted.*

The accompanying figures (112, 113) exhibit the difference, in regard to size and figure, of the drones and workers. The



Fig. 112.—Drone Bee.



Fig. 113.—Worker Bee.

one female, to which we give the name of queen, had always a male epithet applied to her by the ancients; so also, in Shakspeare's splendid description of the economy of a hive:—

> ————"So work the honey Bees;
> Creatures that, by a rule in nature, teach
> The art of order to a peopled kingdom.
> They have a king, and officers of sorts;
> Where some, like magistrates, correct at home;
> Others, like merchants, venture trade abroad;
> Others, like soldiers, armed in their stings,
> Make boot upon the summer's velvet buds;
> Which pillage they with merry march bring home
> To the tent-royal of their emperor:
> Who, busied in his majesty, surveys
> The singing masons building roofs of gold;
> The civil citizens kneading up the honey;
> The poor mechanic porters crowding in
> Their heavy burdens at his narrow gate;
> The sad-eyed justice, with his surly hum,
> Delivering o'er to executor's pale
> The lazy yawning drone."—Henry V. Act i. scene 2.

On the workers the business devolves of collecting honey and pollen, constructing cells, tending the young, and performing all the multiplicity of duties which the common welfare demands. The drones or males take no part in the labours of the hive; and when, by the fertilization of the queen, the

* Mr. Westwood (page 278) estimates the number in a populous hive at 2,000 males, 50,000 workers, and one queen. Some writers state 30,000 as the probable population. Perhaps the difference that exists in the same hive, at different periods, may account for the discrepancy.

great end of their existence is effected, and the continuance of the community is secured, they are dragged forth, and mercilessly stung to death by the workers. To this slaughter, which takes place in autumn, it is probable the poet may have referred, in the concluding lines.

The deference with which the queen is attended in her progress through the hive, her fierce encounters with rivals, the sagacity displayed by her attendants in promoting or in preventing these conflicts, according to the different condition of her subjects, and the conduct of the virgin queen, as she sets forth with her emigrants to found cities no less populous than the one they have forsaken, are matters on which our space does not allow us to dwell. But we must mention in what manner the anarchy which succeeds the death of the queen is terminated, and it is one of the examples with which the study of nature abounds, that the truth is stranger than the fiction. The workers select one or more cells, containing the grubs or young workers in their larva state. They give them more commodious, or, as they are termed, "royal cells;" they feed them with "royal jelly;" and, instead of small-sized sterile workers, they come forth virgin queens, with forms, instincts, and powers of production, altogether different!*

The tongue of the Bee—a piece of admirable mechanism—is furnished with numerous muscles, and protected by sheaths when not in use, yet fitted for being instantaneously unfolded, and darted into the blossom of a flower. Its structure in one of the humble Bees is shown in the accompanying figure (*Fig.* 114). The nectar thus swept up is at once consigned to the honey-bag. This being done, the tongue is sheathed with the same rapidity, retracted in part into the mouth, and the remainder doubled up under the chin and neck, until again required. When needful, the mandibles are called into

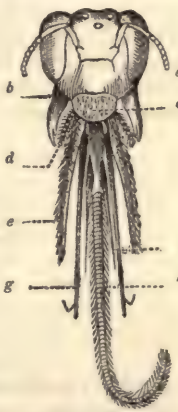


Fig. 114.—Head of Anthophora.

Fig. 114.—*a*, Antennæ.—*b*, Mandibles.—*c*, Labrum.—*d*, Maxillary palpi.—*e*, Maxillæ.—*f*, Lateral lobes of tongue.—*g*, Labial Palpi.—*h*, Tongue.

* Kirby and Spence, vol. ii. page 129.

requisition, and the corolla of the flower is pierced, so that the honey it contains may be more conveniently procured.

The little pellets which we see the Bees carrying home on their hind legs consist of the pollen or farina of flowers. Shakspeare has, therefore, given utterance to the common, but incorrect idea, when he uses the words,

"Our thighs are packed with *wax*."

The pollen, when brought home, is mixed with honey, and forms what is called Bee-bread. The wax itself is not collected from flowers, but is secreted by means of peculiar organs, which may easily be seen by pressing the abdomen so as to cause its distension. It is not a secretion which is constantly going on; it takes place only when required for the construction of comb. To supply it, the wax-workers—which Huber has proved to be distinct from the nurses—are obliged to feed on honey, and remain inactive, generally suspended from the top of the hive, for about twenty-four hours previous to the deposition of the wax.

Mathematicians inform us that Bees have, in their hexagonal cells, given a solution to the problem of how the greatest strength may be combined with the least quantity of material, another proof of the perfection of their instinctive actions.* Wax and honey, the products of their labours, become, in some parts of the world, important articles of commerce. The honey of Mount Hymettus, so celebrated in ancient Greece, even yet retains its celebrity, though all around is changed.

STREPSIPTERA.†



Fig. 115.—STYLOPS (MAGNIFIED).

This order consists of only a single family (*Stylopidæ*, *Fig.* 115)

* See Paley's Natural Theology, edited by Lord Brougham.

† The term is derived from two Greek words, meaning "*twisted wings*," and was given by the Rev. Mr. Kirby, the discoverer of the order, from the first pair of wings being absent, and represented by twisted rudiments." Mr. Westwood regards these insects as "the most anomalous annulose animals with which we are acquainted."—Vol. ii. page 288.

which, however, is one of great interest to the entomologist. The individuals composing it are short-lived, diminutive in size, not exceeding a quarter of an inch, and pass the early stages of their existence as parasites in the bodies of Bees and Wasps, especially in those of different species of solitary bees. With this brief notice of their existence, we proceed to the numerous families of Butterflies and Moths, composing the order

LEPIDOPTERA.*



Fig. 116.—Peacock Butterfly.

The wings are four in number, large, extended, covered on both sides with minute scales, overlapping each other like the slates on the roof of a house; and on their removal showing that the wing itself is membranous. There is a pretty little Moth (*Fig.* 117), by no means rare in some parts of Ireland, which might, at first sight, appear to have a greater number of wings; but they are regarded as four wings only, cut into a number of longitudinal or feather-shaped pieces, so as to resemble a plume or fan.

The mouth of the Lepidoptera differs much from that of any of the insects we have hitherto been considering. The powerful jaws have disappeared, and instead of them we find a slender tubular apparatus, which is carried about coiled up

* "Scale-winged:" the wings, with few exceptions, being covered with fine scales, resembling feathers. About 450 Irish species are known.

like the mainspring of a watch (*Fig.* 118). In a moment it can be darted into a flower to obtain the nectar on which the insect lives, and which is sucked up through the centre of this delicate proboscis. Any one, by applying a pin to this



Fig. 117.—Plumed Moth (magnified).



Fig. 118.—Head of Butterfly.

"tongue"—as it is commonly but incorrectly called—will find that it consists of two pieces, and that by their union the canal is formed, through which the nutriment is imbibed.

The number of these insects is very great. "Dr. Burmeister supposes them to amount to not fewer than 12,000 species; and of these nearly 2000 have been described as British."* In expanse of wing, and beauty of colouring, they stand unrivalled. Some foreign species measure, when expanded, not less than nine or ten inches; and others display tints so splendid that they have been compared to those of gems and flowers.



Fig. 119.—Oak-leaf Moth.

Even in those which are natives of our more northern clime, considerable diversity exists. Some are scarcely distinguishable from the leaves of the plants, or the trunks of the trees on which they repose (*Fig.* 119); others vie with the snow-flake in the purity of their vesture. Some exhibit gorgeous metallic hues; and others an azure surpassing that of the summer sky at noon.

* Westwood, page 310.

They have been divided, according to the times of their appearance, into three groups. Those that fly during the day (*Diurna*), or Butterflies; those that appear in the twilight (*Crepuscularia*), or Hawk-moths; and those that come forth at night (*Nocturna*), or Moths; and though this arrangement is not very precise, it will be sufficiently so for our present purpose.

Many of the most splendid British Butterflies are not found in Ireland; and several species—as, for example, the Peacock Butterfly (*Fig.* 116)—are taken in the South of Ireland, but are quite unknown in the North. Hence, as certain kinds have but a limited range, each change of place brings fresh objects of interest before the eye of the naturalist; and as the appearance of different species is periodical, a similar gratification is connected with each change of season.

Sometimes lepidopterous insects, of species rare or unknown in a certain locality, appear there in considerable numbers for a few days and then vanish not to be seen again for years. Why they do so, is a question which, in the present state of our knowledge, we are quite unable to answer.

But apart altogether from the consideration of such phenomena, the person who studies the habits of this tribe of beings will, in all seasons, and in the most limited locality, find full scope for his mental activity. What can be a more common occurrence than the escape of the Nettle Butterfly from the chrysalis-case. Yet, let any one mark the progress of the phenomena from the time the insect bursts its prison-house until the miniature wings have expanded to their full extent and are ready for flight, and he will admit the truth which Ray long since inculcated. "There is a greater depth of art and skill in the structure of the meanest insect than thou art able for to fathom or comprehend."*

The Lepidoptera of the second great division—those which

* Wisdom of God in Creation, published 1690. The author, John Ray, F. R. S. born in Essex, 1627, was the son of parents of humble rank. He was the founder of true principles of classification, both in Botany and Zoology, and was not more respected for his scientific attainments than for his benevolence and his high moral and religious worth. An association for the publishing of valuable natural history works, has recently been established in these kingdoms, and has called itself "the Ray Society," in honour of this truly illustrious man. It consists of nearly a thousand members; to some of its publications we have more than once referred.

fly most generally in the cool of the morning or evening—have the swiftest and most powerful flight; hence the name Hawk-moths (*Fig.* 120). They are also called Sphinxes, in



Fig. 120.—Sphinx of the Vine.

consequence of the head of the caterpillar being held erect, so as to give it some resemblance to the attitude of the Egyptian Sphinx. The tube, which they insert into the blossoms for extracting the honey, is of considerable length: in one native species (*Sphinx convolvuli*), it measures nearly three inches. Some of the tribe come forth in the brightest sunshine, and have obtained the name of Humming-bird Hawk-moths. One very remarkable, both for its size and markings, is the Death's-head Moth. Its wings, when fully expanded, measure four inches and three quarters across, so that it is the largest of all European Lepidoptera. It has the habit of robbing bee-hives, and is said to utter a sound which stills the busy inmates, and enables their gigantic plunderer to carry off his booty in safety. We have one in our cabinet which was taken in Holywood (Co. Down), while engaged in battling against a sparrow. By the ignorant it has been always regarded with superstitious terror, as the precursor of war, pestilence, and famine.

The remaining tribes are all included under the common name of "moth." The word is sometimes used to express the extreme of littleness. Thus, we have in Shakspeare, "a *moth* will turn the balance;" "wash every *moth* out of his conscience;" and similar expressions. To show how inaccurate is this idea of their diminutive size, it is only necessary to

mention, that the Oak-moth measures three inches and a half across the expanded wings, and the Emperor-moth (*Saturnia pavonia minor*, *Fig.* 121) is of equal dimensions.



Fig. 121.—Emperor Moth.

To such species the lines of Spencer are strictly applicable,—

> "The velvet nap which on his wings doth lie,
> The silken down with which his back is dight,
> His broad outstretch'd horns, his airy thighs,
> His glorious colours, and his glistening eyes. *

The caterpillars of some moths are of large size; those of others are so minute that the thickness of an ordinary leaf is sufficient to afford them concealment, as they eat away its interior;—nay, half its thickness is sufficient, as an examination of any leaf, showing upon one side only their whitish zigzag lines, will testify.

Some, from their peculiar movement, which seem as if they were measuring the space they traverse, are called surveyors (*Geometræ*), and they can fix themselves to a twig in a manner so stiff and motionless as to seem a part of the plant. Others, with inimitable skill, construct vestures for themselves of very different materials, occasionally employing what to us would seem the most unsuitable. Some, like those represented in *Fig.* 122, possess the art of rolling a leaf, so as to convert it to a habitation; and others, spinning a snow-white canopy, dwell together in social communities.

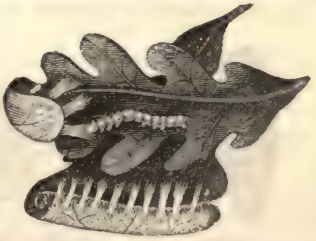


Fig. 122.—Nest of Tortrix.

* From his poem, entitled Minopotmos, or the Fate of the Butterfly.

Our space forbids us to enter into these details, however instructive or interesting they might prove; but we should be inexcusable, did we pass by in silence the effects which the labours of one insect of this order has produced, and is still producing, on the employments and habits of many hundred thousands of human beings. We allude, of course, to the Silkworm-moth (*Bombyx mori*, *Fig.* 125) whose larva (*Fig.* 123) forms the cocoons from which silk is manufactured.



Fig. 123.—Silkworm.

There was a time when this article, now so abundant, was valued in Rome at its weight in gold,* and the Emperor Aurelian refused his empress a robe of silk because of its dearness. At that very period the Chinese peasantry, amounting in some of the provinces to millions in number, were clothed with this material; and both there and in India it has formed, from time immemorial, one of the chief objects of cultivation



Fig. 124.—Chrysalis of Silkworm.



Fig. 125.—Silkworm Moth.

* From Kirby and Spence, Intr. vol. i. page 331.

and manufacture. About the year 550 the eggs were brought to Constantinople, thence they were introduced into Italy, and under the auspices of Henry IV. of France, the cultivation of silk was commenced in his dominions. In its various states, it now constitutes in many parts of the world so important an article of commerce, that the learned authors, from whom we have taken these particulars, remark, "that when nature

> ——"Set to work millions of spinning worms,
> That in their green shops weave the smooth-hair'd silk,
> To deck her sons."—MILTON.

she was conferring on them a benefit scarcely inferior to that consequent upon the gift of wool to the fleecy race, or a fibrous rind to the flax or hemp plants."

HEMIPTERA.*



Fig. 126.—PENTATOMA (LOWER SURFACE).†



Fig. 127.—HALYS (UPPER SURFACE).

In the insects belonging to this order the mouth is formed for abstracting the juices of animals or plants (*Fig.* 126). The wings are four in number, partly overlapping each other, and with the portion towards the base of each wing tougher, or more coriaceous than the other portion, which is membranous. In some genera the coriaceous part is so small as to be inconspicuous; and such insects have, by modern entomologists, been separated from the others, and designated by a term expressive of uniformity in the appearance of the wings. An example of this structure is afforded by an insect, whose name

* Half-winged. About 150 Irish species.

† This figure exhibits the shape and jointed structure of the proboscis, and its position when not in use. The legs and antennæ are represented as cut off near the base.

is familiar to every classic reader—the Cicada (*Fig.* 128). Its image, made of gold, was worn by the Athenians in their hair, and to excel its song was the highest commendation of a singer. We quote two stanzas from a spirited ode by Anacreon, addressed to the Cicada, as illustrative of the estimation in which it was formerly held.*



Fig. 128.—Cicada.

"Thine is each treasure that the earth produces;
Thine is the freshness of each field and forest;
Thine are the fruits, and thine are all the flowers,
Balmy spring scatters.

"Thee, all the muses hail a kindred being;
Thee, great Apollo owns a dear companion;
Oh! it was he who gave that note of gladness,
Wearisome never."

The clamorous "Catydids" of North America belong to this tribe; one species has been discovered in England.

The strange-looking creatures to which travellers have given the name of Lantern-flies, and which we see in our museums, belong to the present order. But better known to every inhabitant of these countries is the frothy substance known by the name of Cuckoo-spit, common on plants during

* The translation is extracted from the Entomological Magazine.

the summer months. It is an exudation proceeding from the larva of a little insect (*Aphrophora spumaria*), and affording it, at the same time, concealment from enemies and protection from vicissitudes of weather.



Fig. 129.—Larva of Aphis (magnified).



Fig. 130.—Aphis (magnified).

The minute insects which are black upon the woodbine, green upon the rose, and which have a cottony appearance upon the apple-tree, are all of them different species of Aphides or plant-lice (*Figs.* 129, 130).

> ——"A feeble race, yet oft
> The sacred sons of vengeance, on whose course
> Corrosive famine waits, and kills the year."—Thomson.

When very numerous, they weaken and occasionally destroy the plants on the juices of which they subsist. The saccharine fluid of which the Ants are so fond is secreted by the Aphides; they are preyed upon and destroyed by insects of other orders. The most remarkable circumstance connected with their history, is their extreme fecundity, and the singular provision for the preservation of the race from year to year. A common species which infests the apple, and is known as the American Blight (*Aphis lanigera*), produces, in the course of a season, eleven broods of young. The first ten broods are viviparous, or are brought forth alive, and consist entirely of females. These never attain their full development as perfect insects; but, being only in the larva state, bring forth young, and the virgin Aphides thus produced are endowed with similar fecundity. But at the tenth brood this power ceases.

The eleventh does not consist of active female larvæ alone, but of males and females. These acquire wings, rise into the air, sometimes migrate in countless myriads, and produce eggs which, glued to twigs and leaf-stalks, retain their vitality through the winter. When the advance of spring again clothes the plants with verdure, the eggs are hatched, "and the larva, without having to wait for the acquisition of its mature and winged form, as in other insects, forthwith begins to produce a brood as hungry and insatiable, and as fertile as itself." Supposing that one Aphis produced 100 at each brood, she would at the tenth brood be the progenitor of one quintillion of descendants!—1,000,000,000,000,000,000![*]

There is another tribe known to gardeners as scale insects, or mealy bugs, which are very destructive, especially to our hot-house plants. They constitute the family *Coccidæ*. The female, from her motionless aspect, bears a greater resemblance to a gall or excrescence upon a leaf than to a living insect with numerous young. But if these singular and inert beings are the cause of occasional injury to man, they repay the damage a hundredfold, by furnishing him with the brilliant scarlet dye known in commerce by the name of cochineal. The insect from which this is procured is the *Coccus Cacti*, of Mexico. It is found upon a plant termed "Cactus Cochinellifer," and is collected in such quantities, that, according to Humboldt, 80,000 pounds of cochineal are annually brought to Europe, each pound containing about 70,000 insects; and Dr. Bancroft estimated the weight of that annually consumed in England at 150,000 pounds, worth £370,000.[†] Lac, a substance much used for varnishes, sealing-wax, &c. is produced by another species of the same family.



Fig. 131. Notonecta.

Every pond affords examples of other insects whose structure exhibits, in a more obvious manner, the characteristics of the order. There we find the Boat-fly (*Notonecta, Fig.* 131), which rows gracefully along upon its back; and the Water-scorpion (*Nepa, Fig.* 132), in which the dark external covering of our most common native species contrasts beautifully with the scarlet body underneath; and others which glide

[*] Owen, page 235.—*Vide* foot note, page 154.
[†] Westwood, pages 448, 449.

rapidly along, or perform a more unusual feat—that of walking upon the surface of water.



Fig. 132.—Nepa.

To the present order belongs one insect, universally regarded as a very disgusting visitant (the Bed-bug, *Cimex lectularius*, *Fig.* 133). This creature would appear to be much more common now than in the days of Queen Elizabeth; for, although Shakspeare mentions several insects in his plays, and the word Bug occurs five or six times, it is never applied to the insect, but is always used as synonymous with Bugbear.* It is destitute of wings, differing in this respect from some of those (*Figs.* 126, 127) which feed on the juices of plants, and are sometimes of large size and brilliant colours.



Fig. 133.—Bed-bug (magnified).

DIPTERA.†

This order consists entirely of two-winged flies. The wings are membranous. The mouth is formed for suction; and in certain tribes, such as the Gnat (*Fig.* 134), the Gad-flies, &c. it is furnished with lancet or razor-shaped organs, to enable it to pierce the skin. So great is the number, not only of individuals but of species, that above a thousand species fully described and named are recorded as indigenous to Ireland. We do not, therefore, attempt any enumeration of the different families or their distinguishing characteristics, but merely bring forward a few examples of their powers, whether beneficial or injurious.

The larvæ of some species live in the most disgusting substances, and speedily effect their removal. Of the family (*Muscidæ*) to which the House-fly, the Blue Bottle-fly, &c. belong, Meigen has described nearly 1,700 European species. Among these are the Flesh-flies, whose office it is to consume

* Thus, "Tush! tush! fear boys with *bugs*."
"The *bug* which you will fright me with I seek."

† Two winged. About 1050 Irish species.



Fig. 134.—Gnat (magnified).



Fig. 134.—Larva (magnified.)

the dead and decaying bodies of animals, which soon would taint our atmosphere. They are gifted with wonderful powers for effecting this object. The young are brought forth alive, and the female will give birth to twenty thousand young.* Hence the assertion of Linnæus, with regard to *Musca vomitoria*, that three of these flies would devour a dead horse as quickly as a lion would, is perhaps not much overstrained.

So far these insects are the benefactors of man. Let us now regard them as his tormentors, or as the cause of irritation and suffering to many of his most valuable quadrupeds.

According to Arthur Young, flies—that is, the common House-flies—constitute "the first of torments in Spain, Italy, and the olive districts of France. It is not," continues he, "that they bite, sting, or hurt, but they buzz, tease, and worry. Your mouth, eyes, ears, and nose are full of them; they swarm on every eatable; fruit, sugar, milk, everything is attacked by them."† Humboldt, in his Personal Narrative, frequently mentions "these noxious insects, which, in spite of their littleness, act an important part in the economy of Nature." The annoyance occasioned by the Mosquito is noticed by every traveller in the southern parts of Europe and the northern parts of Asia and America. Dr. Clarke states, in his journey along the frontier of Circassia, that the Cossack soldiers "pass the night upon the bare earth, pro-

* Westwood, page 569, on the authority of De Geer and Reaumur.
† Travels, vol. ii. page 35.

tected from the Mosquitos by creeping into a kind of sack sufficient only for the covering of a single person.*

Let us now notice, with equal brevity, the sufferings inflicted by insects on some of our domestic animals. No words which we could use for this purpose would be so graphic as those of Spencer:—

> "As when a swarme of Gnats at eventide
> Out of the fennes of Allan doe arise,
> Their murmuring, small trumpets sounden wide;
> Whiles in the air their clust'ring armies flyes,
> That as a cloud doth seem to dim the skyes;
> Ne man nor beast may rest, or take repast,
> For their sharp wounds and noyous injuries;
> 'Till the fierce northern wind, with blustering blast,
> Doth blowe them quite away, and in the ocean cast."
>
> FAERY QUEENE, Book II. c. ix. st. 16.

Besides being subjected to the biting of Gnats, our horses and oxen suffer from the various species of Gad-flies (*Tabanidæ*, *Fig.* 135), which make them the peculiar object of attack. They pierce the skin, and suck the blood, their razor-shaped weapons performing the double office of making the wound and pumping out the liquid. The peculiar noise which they make, and which has gained them the name of "the breeze," constitutes of itself a source of fright and annoyance.†



Fig. 135.—TABANUS.

Perhaps the terror caused by the Bot-flies, or Œstri (*Fig.* 136), is still more striking; it has long been observed, for it is accurately described by Virgil.‡ Each species of Œstrus not only selects the peculiar species of quadruped on which it is parasitic, but with unfailing instinct fixes its eggs in the situation best adapted for the welfare of its future progeny.§ Thus, the species which attacks the ox deposits its eggs on the back of the animal, and these, when hatched, produce the

* Travels by Edward Daniel Clarke, LL.D. 2d edition, page 387.
† Westwood, page 539.
‡ Georgics, Book III.
§ Bracey Clarke in Trans. Linnæan Society.



Fig. 136.
Œstrus.



Fig. 137.
Larva.

tumours known among the country people by the name of "wurbles;" while one devoted to the horse fixes them on the parts most liable to be licked by the animal. They are thus taken into the stomach, and there they remain at a temperature of one hundred degrees, until they attain their full size, as the larvæ so well known by the name of "bots" (*Fig.* 137).

But it would be unjust to allow the reader to leave the Dipterous insects without bringing some of the tribes before him in their hours of enjoyment. Every person is familiar with the appearance of that large-winged, long-bodied insect, known as the "Harry Long Legs;" the largest species we have of the *Tipulidæ*. The members of this family and those which are spoken of as "Midges" (*Culicidæ*) have long been noted for their aërial dances. Every one has observed how they come forth in the sunshine, how they sometimes keep pace with the traveller as he journeys along,* and how even in winter they occasionally present themselves in multitudes. Some instances are recorded of their appearing in such numbers as to excite surprise, and even alarm. Thus, in Phil. Trans. 1767, it is stated that in 1736 the common Gnat (*Culex pipiens*) rose in the air from Salisbury Cathedral in columns so resembling smoke, that many people thought the cathedral was on fire. In Norwich, in 1813, a similar alarm was created. At Oxford, in 1766, "a little before sunset, six columns of them were observed to ascend from the boughs of an apple-tree, some in a perpendicular, and others in an oblique direction, to the height of fifty or sixty feet."

For some successive evenings towards the middle of June, 1842, a phenomenon similar to that last mentioned was observed by us in the vicinity of Belfast. "The insects appeared in columns above the trees, the shade of colour varying according

* This circumstance has been thus noticed by Wordsworth:—

"Across a bare, wide common I was toiling,
With languid feet, which by the slippery ground
Were baffled; nor could my weak arm disperse
The hosts of insects gathering round my face,
And ever with me as I paced along."—The Excursion.

to the greater or less density of the mass, from that of light vapour to black smoke, the columns not only differing in this respect from each other, but each column being frequently different in different parts. They might have been mistaken for dark smoke-wreaths but for their general uniformity of breadth, and for a graceful and easy undulation, similar to that of the tail of a boy's kite, when at some height and tolerably steady. The individual insects flew about in each column in a confused and whirling multitude, without presenting in their mazy dance any of those regular figures which Gnats frequently exhibit over pools of water, while the motion of their wings filled the air with a peculiar and not unmelodious humming noise. The columns rose perpendicularly to the height of from 30 to 60 feet, and in some instances to the height of 80 feet. They were equally abundant over trees of every kind, as ash, beech, birch, poplar, &c.; and so numerous were these distinct columns, that so many as from 200 to 300 were visible at the same time. As each column was every instant undergoing a change in density of colour, diameter, elevation, or form, the phenomenon was one of exceeding interest, especially as connected with the living myriads which, in these aërial gambols, gave expression to their enjoyment."

If we ask, why do they thus associate together? by what principle are they impelled to congregate in this ever-varying dance? we are unable to give any reply to the question more just, or more philosophical, than that suggested by the Poet:—

> "Nor wanting here, to entertain the thought,
> Creatures that in communities exist,
> Less as might seem for general guardianship,
> Or through dependence upon mutual aid,
> Than by participation of delight
> And a strict fellowship of love combined;
> What other spirit can it be that prompts
> The gilded Summer-flies to mix and weave
> Their sports together in the solar beam,
> Or in the gloom of twilight hum their joy?"—WORDSWORTH.

APTERA.*

UNDER this term numerous insects, and tribes allied to insects, have, since the time of Aristotle, been artificially grouped together, the common bond of union being their agreement in the negative character derived from the absence of wings. The Linnæan order *Aptera* is subdivided by modern entomologists into four orders.

I. MYRIAPODA.—Insects which are possessed of numerous feet, such as the Centipede and the Millepede, belong to this order. The Centipede (*Scolopendra*, *Fig.* 139) is carnivorous

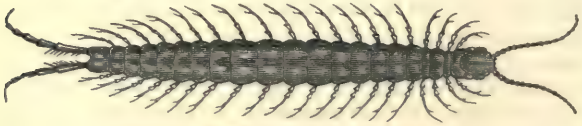


Fig. 138.—SCOLOPENDRA.

in its habits, an infuses a poisonous secretion into the wound inflicted by its mandibles. Some of the foreign species of Centipede are above a foot in length, and proportionately formidable. The Millepede (*Julus*, *Fig.* 139) feeds principally on decaying vegetable matter, and is frequently found under the bark of trees, coiled up like the mainspring of a watch.



Fig. 139.—JULUS.

II. THYSANOURA (*fringed-tail*).—In this order there is great diversity of structure; but the peculiarity whence the name of the order is derived, will be understood by reference to

* *Without wings.* The *Crustacea* and *Arachnida*, which now constitute distinct classes, were formerly included in this order.

Fig. 140), representing an insect which frequents stony places, and is allied, in its structure, to that found in sugar (*Lepisma*). The name *Podura*, meaning literally a "leg in the tail," was bestowed by Linnæus on those which have the tail forked



Fig. 140.
MACHILIS (MAGNIFIED).



Fig. 141.—PODURA (MAGNIFIED).



Fig. 142.—THE COMMON LOUSE (MAGNIFIED), WITH THE EGGS THE NATURAL SIZE AND MAGNIFIED.

(*Fig.* 141). It is kept bent underneath the body when not in use; when unbent it acts as a spring, and has given origin to their English name of Spring-tails."* Some species abound on pools, leaping even on the surface of the water; others may be found under stones or beneath decaying leaves.

III. PARASITA.—The Louse (*Fig.* 142) and its allies—insects parasitic on man and the lower animals—form the numerous but unpopular genera comprised in the present order.

* A Paper, by Robert Templeton, Esq. on the Irish species of spring-tailed insects, is published in the Transactions of the Entomological Society, vol. i.



Fig. 143.
FLEA (MAGNIFIED).

IV. SUCTORIA.—These insects may be represented by the common Flea (*Pulex irritans, Fig.* 143). The mouth of the Flea is formed for suction, and the hind legs for jumping. The length of its leap has been measured, and found to be two hundred times that of its body—an extraordinary instance of muscular power.

CLASS V.—ARACHNIDA—SPIDERS, &c.



Fig. 144.—MYGALE.

THE present class includes Mites, Scorpions, and Spiders. They exhibit a more concentrated state of the nervous system than insects; they do not undergo similar transformations; and in the larger tribes there is a higher condition of the respiratory system; for they breathe not by air tubes, but by "air sacs, or lungs."* They differ from true insects, also, in their having four pair instead of three pair of legs.

The eyes vary in number and position, but are never compound. Spiders have the sense of hearing, but neither the organ nor its situation is known: the same may be said of the sense of smell.

* Owen, pages 250, 251 257, 260.

All Spiders secrete a poisonous fluid, which is, no doubt, formidable and even fatal to insects, though it produces but little effect on the human frame. The poison is conveyed through a perforated fang in the mandibles. In the Scorpion (*Fig.* 145),



Fig. 145.—Scorpion.

on the contrary, it is lodged in the extremity of the slender flexible tail, and the wound is inflicted by the recurved sting by which the tail is terminated.

Spiders have another secretion, still better known;—that which furnishes the material of which their threads are composed. The little teats, whence the threads proceed, are at the hinder extremity of the body, and are four, six, or eight in number. Each of these is composed of orifices so fine, that Leeuwenhoek and other eminent microscopic observers have regarded a Spider's thread, even when so fine that it is almost imperceptible to our senses, not as a single line, but as a rope composed of at least four thousand strands. From Mr. Blackwall's observations, there is reason to think that this estimate is too high, and that the total number of the *papillæ*, whence the lines proceed, does not greatly exceed a thousand; yet, even admitting this to be the case, our wonder at the complex structure of a Spider's thread is scarcely lessened.*

That any creature could be found to fabricate a net, not less ingenious than that of the fisherman, for the capture of its prey; that it should fix it in the right place, and then patiently await the result, is a proceeding so strange, that if we did not see it done daily before our eyes by the common House-spider and Garden-spider, it would seem wonderful; but how much is our wonder increased when we think of the complex fabric

* Trans. Linnæan Society, vol. xvi. page 220.

of each single thread, and then of the mathematical precision and rapidity with which, in certain cases, the net itself is constructed; and to add to all this, as an example of the wonders which the most common things exhibit when carefully examined, the net of the Garden-spider consists of two distinct kinds of silk. The threads forming the concentric circles are composed of a silk much more elastic than that of the rays; and are studded over with minute globules of a viscid gum, sufficiently adhesive to retain any unwary fly which comes in contact with it. A net of average dimensions is estimated by Mr. Blackwall, to contain 87,360 of these globules, and a large net of fourteen or sixteen inches in diameter, 120,000; and yet such a net will be completed by one species (*Epeira apoclisa*) in about forty minutes, on an average, if no interruption occur.* In ordinary circumstances, the threads lose their viscidity by exposure to the air, and require to have it renewed every twenty-four hours. Any observer, by scattering a little fine dust over the web, may satisfy himself that it is retained only on the circles where the minute globules are placed, and not upon the radii.† If the globules are removed, both lines are unadhesive; but in other respects they are essentially different, the circular lines being transparent and highly elastic, while the radial lines are opaque, and possess only a moderate degree of elasticity. The astronomer finds the opaque silk of the radial lines and of the egg-bag a convenient substitute for platina wires in the telescopes attached to his instruments; but the silk of the circular lines being transparent, is, from that circumstance, unsuitable for his purpose.‡ The nets of some Spiders are constructed under water—the secretion being insoluble—and are spread out for the capture of aquatic insects.

A great deal of false commiseration has been bestowed upon the flies which fall victims to the voracity of the Spider, who has accordingly been regarded as "Cunning and fierce, mixture abhorred." But considered aright, there is no cruelty in any animal exercising, for its support, those powers with which it has been endowed by its Creator. It does not kill

* Trans. Linnæan Society, vol. xvi. page 478.

† Kirby and Spence, vol. i. page 419.

‡ This fact has been very kindly communicated to us by the Rev. Dr. Robinson, Armagh Observatory. The silk there employed is procured from the egg-bags of the common Garden Spider (*Epeira Diadema*).

from wantonness but from necessity. It must kill, or it must cease to live.

Gossamer, the origin of which was formerly conjectural, is now known to be the production of a minute Spider. Spencer speaks of it as "scorched dew," and Thomson regards it as "the filmy threads of dew evaporate."

Spiders have been divided into families, which present very considerable differences in their modes of life. Some are hunters, and live by the chase; some leap upon their prey; some more deliberately move sideways or backwards, as the exigency requires; some fix long threads and prowl about them to secure their game, while others construct nets of various kinds in the air, or exercise their skill in the water.

Not less varied are their habitations. Perhaps the most remarkable is that of the *Mygale cæmentaria*, who, having formed a subterraneous tube or gallery, lines it with silk, and constructs a door formed of several coats of cemented earth and silk. "This door (*Fig.* 146) the ingenious artist fixes to the entrance of her gallery by a hinge of silk; and, as if acquainted with the laws of gravity, she invariably fixes the hinge at the highest side of the opening, so that the door, when pushed up, shuts again by its own weight." The part against which it closes with great accuracy, and the defences by which it is secured, are not less excellent as mechanical contrivances.



Fig. 146.—Nest of Mygale.

The female Spider is remarkable for her parental affection. One species (*Epeira fasciata*) makes an elaborate envelope for her eggs, attaches it to a branch of a high tree, and guards it with ceaseless vigilance. The habits of another are thus described by Professor Hentz: "When a mother is found with the cocoon containing the progeny, if this be forcibly torn from her, she turns round and grasps it with her mandibulæ (mandibles). All her limbs, one by one, may then be torn from her body without forcing her to abandon her hold. But if, without mangling the mother, the cocoon be skilfully removed from her, and suddenly thrown out of sight, she

instantaneously loses all her activity, seems paralysed, and coils her tremulous limbs, as if mortally wounded: if the bag be returned, her ferocity and strength are restored the moment she has any perception of its presence, and she rushes to her treasure to defend it to the last."

We now close our notice of the Articulated animals. We have spoken of Worms, Barnacles, Crabs, Insects, and Spiders; to common observers a motley and unattractive group. Yet, how varied in their structure! how wondrous in their habits! To the humble-minded and patient observer, they are suggestive of ideas and emotions too multiplied and fugitive to be embodied in words, but affording an example of the truth so beautifully expressed by the poet:—

"The air in which we breathe and live,
Eludes our touch and sight;
The fairest flowers their fragrance give,
To stillness and to night:
The softest sounds that music flings,
In passing from her heaven-plumed wings,
Are trackless in their flight!
And thus life's sweetest bliss is known
To silent, grateful thoughts alone."—B. BARTON.

NOTE.—1854. APHIDES, page 141. The terms "virgin aphides" and "larva state" can no longer be considered strictly applicable. The successive broods owe their origin not to female aphides, but to sexless individuals which are capable of reproduction by a process of *budding*. "The germs," to use the words of Dr. Burnet, "are situated in moniliform rows, like the successive joints of confervoid plants, and are not enclosed in a special tube." "What interpretation shall we put on these reproductive parts—these moniliform rows of germs?" Ignoring all existing special theories relating to reproduction, the observing physiologist would be left no alternative but to regard them as *buds*, true gemmæ, which sprout from the interior surface of the aphis, exactly like buds, from the external skin of a Polype."—Dr. Burnett on the development of viviparous aphides. American Journal of Science and Arts. January, 1854.

MOLLUSCA.

"Oh! what an endlesse work have I in hand,
To count the sea's abundant progeny!
Whose fruitful seede farre passeth those in land,
And also those which wonne in the azure sky;
And much more eath to tell the starres on hy
Albe they endlesse seeme in estimation;
Then to recount the sea's posterity,
So fertile be the flouds in generation,
So huge their numbers, and so numberlesse their nation."
SPENSER'S FAERY QUEENE, Book iv. canto xii.

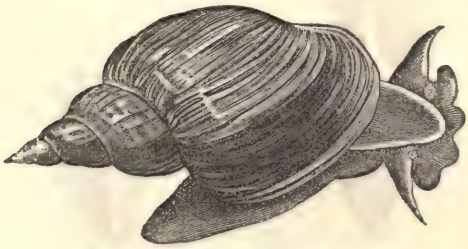


Fig. 147.—LYMNEUS STAGNALIS.

THE soft-bodied animals, to which the term "*Mollusca*" is applied, constitute another of the primary groups of the animal kingdom. In them we see no longer the jointed or articulated structure characteristic of the crustacea and insects. The body, as the very name of the group implies, is soft, and it is devoid of the jointed legs, which, in some of the preceding tribes, were applied to such diversified uses. The nervous system is also different, being unsymmetrical; it consists of a ring surrounding the gullet, with one or two ganglions or knots of nervous matter connected with similar masses in other parts of the body. "The blood is colourless, or not red,"* and the respiratory organ or gill, which is never

* Owen, page 13.

wanting, presents great diversity in position and figure, and is, in some species, a very remarkable and attractive object.

The Mollusca are very widely diffused, abounding not only in tropical and arctic seas, but in lakes, ponds, and rivers. Some, round our coasts, are found buried in sand or mud; others construct their dwellings in indurated clay, and even in limestone rocks. Some species (*Fig.* 147) delight in quiet sunny nooks, on the margin of fresh-water pools; some in rapid and mighty rivers; and others dwell in the ocean at depths which have been but seldom explored by the dredge of the naturalist. But though the greater number are aquatic, all are not so. The terrestrial species, even in our own country, are found in our pastures, our gardens, and our plantations; some may be found on sandy banks, others in moist and shady places; some lurking under withered leaves, and others at various heights on the trunks of our forest trees.



Fig. 148.—Buccinum.



Fig. 149.—Volute.

The beautiful variety of form (*Figs.* 148, 149, &c.) observable in the shells of different species of Mollusca, has, in all ages, attracted attention; and the splendour of their colouring is not surpassed by that of our brightest garden-flowers. In some respects it is even superior, for their most delicate tints become here unfading and permanent; and a peculiar structure of the surface gives rise occasionally to iridescent hues. Among savage tribes, shells are formed into elaborate ornaments, and applied to numberless uses. In a part of Africa a species of shell called "cowry" is the current coin. The *wampum* belts of some of the North American Indians, whether constituting their records or presented to strangers when they enter into or recognise a treaty of amity, are

formed of shells. "The thin inner layers of some large flat bivalves, when polished, are used in the south of China, and in India, instead of glass, for windows."* Many of the domestic utensils of uncivilised nations are shells; and they are converted into drinking-cups, knives, spoons, fishing-hooks, and even razors. "In Zetland, one of our common univalve shells (*Fusus antiquus*), suspended horizontally by a cord, is used as a lamp, the canal serving to hold the wick, and the cavity to contain the oil." In former times the scallop (*Pecten maximus*, or *opercularis*) was worn by religious pilgrims, a custom occasionally referred to by our poets. Thus, Parnell says of his hermit,—

> "He quits his cell, the pilgrim staff he bore,
> And fixed the *scallop* in his hat before."

The difference in point of size is not less remarkable than that of the form and colouring. The Tridacna, or Giant Clamp-shell (*Fig.* 150) is said to attain occasionally a weight

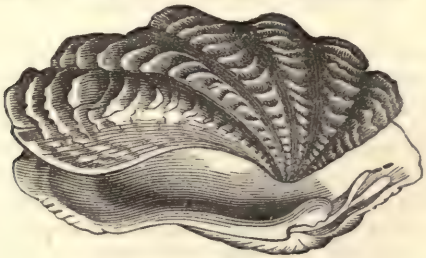


Fig. 150.—TRIDACNA.

of more than 500 pounds; from which circumstance the story may have originated of an oyster which furnished a dinner to a whole regiment. Let us, in imagination, contrast with this the microscopic chambered shells, of which Soldari collected the astonishing number of 10,454,† from less than an ounce and a half of stone found in the hills of Casciana, in Tuscany. "Some idea of the diminutive size of these shells may be

* From a series of papers on Molluscous animals, in Mag. Nat. Hist., from the pen of Dr Johnston, author of Hist. of British Zoophytes, &c.

† Dr. Buckland's Bridgewater Treatise, vol. i. page 117. They were doubtless *Foraminifera*, shells, not produced by mollusca, but by *Rhizopods*, animals of a much lower organization. *Ante*, p. 4.

formed from the circumstance, that immense numbers of them passed through a paper in which holes had been pricked with a needle of the smallest size." Even without going to foreign countries, or having recourse to the microscope, we have, on our own shores, examples of shells remarkable for their minuteness. On one occasion we gathered some handfuls of a small univalve shell (*Paludina muriatica.*—Lamarck), which was lying in dark, irregular patches on the strand, near Belfast. It bore considerable resemblance, except in size, to the common fresh-water species (*Fig.* 151). The weight of four quills, when filled with these shells, was 80 grains; and, as twenty-two of the shells, with their contained animals, weighed only two grains, the number of shells thus enclosed was 880. The weight of the quills and their contents, when enclosed in a letter, was less than half an ounce; and we were, therefore, enabled to transmit 880 living animals and their habitations from Belfast to Dublin, per mail, for one penny.



Fig. 151.
PALUDINA.

We have just used the word "habitations," and it is in this light that shells should be viewed. They are not beautiful productions formed merely to please the eye, but are mansions constructed by molluscous animals for their own especial use and safety. How much is the worth of a shell enhanced in our eyes by this one consideration! Before, it seemed little else than a toy, a pretty thing to look at, and nothing further; but now it assumes an interest in our thoughts;—we ask, how was it fashioned? of what is it composed? whence were the materials derived? by what means was it so exquisitely coloured? by what architectural skill was the edifice so contrived that it was adapted, at all periods, to the progressive growth and requirements of its occupant?

The shelly matter is secreted by a peculiar organ, termed the "collar" in shells consisting of one piece (*univalves*), such as the common snail-shell; and by the margins of the cloak or mantle in those of two pieces (*bivalves*), such as the oyster or the cockle. The shell was formerly regarded merely as an exudation of calcareous matter, held together by a kind of animal glue. But microscopic observation has shown, that it is a membrane composed of minute cells, dif-

fering in size, shape, and arrangement, in different families, and containing secreted calcareous matter. There seems reason to believe, "that this membrane was, at one time, a constituent part of the *mantle* of the Mollusk;" and Dr. Carpenter regards the cells as "the real agents in the production of shell, it being their office to secrete into their own cavities the carbonate of lime supplied by the fluids of the animal."*

The deposition of the colouring matter is the province of glands situated on the margin of the cloak or collar; and in many instances we are able to trace an agreement in the pattern or tracings on the shell and the arrangement of the colours in the secreting organ. Thus, in the banded Snail, there are as many coloured spots on the edge of the collar as there are zones on the shell; and if a part of the margin of the shell be cut away, the piece reproduced is brown opposite to the dark portion of the collar, but in other parts yellow.

The changes of form which shells undergo, as they approach maturity, is sometimes so great, that the full-grown specimen is altogether different from the appearance presented by the same shell in its immature state. Of this the common Leg-of-mutton Shell (*Aporrhais pes pelicani*, *Fig.* 152) of our shores, and the beautiful tribe of Cypræas (*Fig.* 153), furnish familiar examples. We have reason to believe that there is, in all cases, an effort on the part of the animal to accommodate the form of its mansion to the changes in the form or dimensions of its body. Professor Owen† has stated that an oyster kept without food will frequently expend its last energies in secreting a new layer, "at a distance from the old internal surface of the concave valve, corresponding to the diminution of bulk which it has experienced during its fast, and thus adapt its inflexible outward case to its shrunken body."

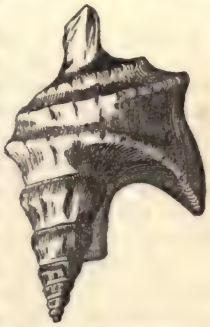


Fig. 152.—Aporrhais.

It has been justly remarked, that the beauty of shells was for ages exerting an influence injurious to the study of

* On the Microscopic Structure of Shells. Report of British Association, 1844.

† Proceedings Zoological Society, No. liv

conchology on philosophical principles, for it fixed the attention of men more upon the covering than upon the humble animal contained within. Such was not the spirit with which Aristotle regarded them; for the structure and habits of the creatures were the main objects of his study, while their relations to the other animated beings by which they were surrounded, and their own mutual affinities, were not forgotten.* To conchology as a science, Pliny added nothing that Aristotle did not supply; but he has furnished some anecdotes regarding its economical applications, and has graced its history with some amusing fictions.

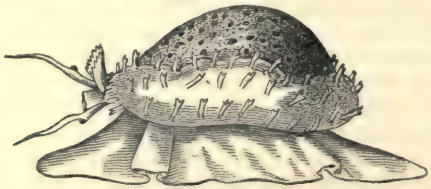


Fig. 153.—CYPRÆA.

Passing from the ancients to the distinguished Swede, whose labours in the last century have done so much for the advancement of natural science, we come to the system of Linnæus, which was perfected in 1766. Shells were at that time arranged into three primary divisions—univalve, bivalve, and multivalve—according to the number of pieces of which the shell was composed. The animals were spoken of as *naked* mollusca, when, like our common slug, they were destitute of an external shelly covering, and as *testaceous* mollusca (*testa*, a shell), when, like the garden snail, they were furnished with this protection. In the system of Linnæus, the testaceous mollusca occupy one order by themselves, in which there are four sections—multivalve, bivalve, univalves with a regular spire, and univalves without a regular spire. The naked tribes are placed in the order denominated "mollusca," along with worms, zoophytes, and star-fishes.

"In estimating," says Dr. Johnston, "the merits of this system, it is not fair to look back from our present vantage-ground, and magnify its defects by a comparison with modern

* The few remarks here made on the progress of conchology are taken from an article by Dr. Johnston, in Magazine of Zoology and Botany, vol. ii. page 238.

classification: we are, in candour, to place ourselves behind its author, and, looking forward, say how far his efforts have been useful or quickening." "The superiority of it lies in its simplicity; in the regular subordination of all its parts; in the admirable sagacity with which the families or genera are limited;" in the conciseness of the specific characters, the skill with which they were chosen, and the facility with which species could be named. It labours under the censure of having too small a regard to the animals, and to their position in the groups, as regulated by the affinities of their organization.

We now pass on to the labours of Baron Cuvier, who, when scarcely nineteen years of age, went, in 1788, to reside some time at Caen, in Normandy. There the marine mollusca attracted his attention, and he commenced that series of observations on their habits and investigations into their anatomical structure which afterwards formed the sure and enduring basis of his classification. Cuvier's object was not merely "to give us a key to the name, but to make that key open, at the same time, a knowledge of the structure and relations of the creature." According to his system, the student, when in search of the name and place of an object, was obliged, at the same time, to acquire a knowledge of its principal structural peculiarities. On these again, as Cuvier beautifully explained, all its habits in relation to food, to habit, and to locomotion, were made dependent. His division of the animal kingdom into four primary groups or sub-kingdoms has already been mentioned; the essential character of the mollusca, as one of these groups, has also been stated. It is derived from the peculiar arrangement of the nervous system, consisting of some ganglions scattered, as it were, irregularly through the body, and from each of which nerves radiate to its various organs. Their further division into classes is founded on characters derived from the organs of locomotion, or others not less influential.

Since the time of Cuvier, the system which he propounded has been elaborately worked out in detail by succeeding naturalists, and has, from time to time, been slightly modified, according to the advance of knowledge; but in its essential characteristics it remains unchanged. Dr. Johnston, in speaking of the effects of Cuvier's example and views, remarks: "They raised the character of the conchologist, and gave a more philosophical tone to his pursuit; they originated a new

school, with better directed zeal and a higher aim, and numbers became disciples when they saw that here as much satisfaction and profit were to be reaped as in the study of almost any other class; for it may be laid down as an axiom, that no branch of natural history, however apparently trifling, "but may be ennobled by the manner in which it is pursued; and when the student carries all its wonders back to the one Great Source, the smallest worm, and the most beautiful of his own species, will afford him subjects for the deepest contemplation."

We now proceed to examine some of the leading divisions of the mollusca. The first and most obvious is into two great groups, one containing those which, like the common oyster, are destitute of a head (*Acephala*); and the other those which, like the snail, are provided with a head, and generally with mouth, eyes, and tentacula (*Encephala*).* Each group is divided into three classes—the former "according to the modifications of the integument or of the gills;" the latter, according to those of the locomotive organs. We shall briefly notice the characteristics of these six classes, and enumerate some of the best known examples of each.

* The names of the classes into which the mollusca are divided may be exhibited thus:

ACEPHALA.

I.	Tunicata	with a cloak or tunic.
II.	Brachiopoda	arm-footed.
III.	Lamellibranchiata	plate-shaped gills.

ENCEPHALA.

IV.	Pteropoda	wing-footed.
V.	Gasteropoda	belly-footed.
VI.	Cephalopoda	head-footed.



Fig. 154.—Porophora.*

There are some Mollusks which are not naked like the slug, nor provided with a shelly citadel like the oyster, but are furnished with a kind of leathery covering or tunic, and are hence termed "*Tunicated.*" They have already been casually mentioned in our notice of the higher organized polypes (page 27), to which, in certain points of structure, they present a considerable affinity. Some of them are aggregated together, and form compound animals; others are solitary, and so inert that to common observers they exhibit no indications of life. The kind best known to our fishermen is a solitary species (*Ascidia communis*) about the size of the largest common mussel, and to which, from its shape, the name of "paps" is given. The exterior is darkish, warty, and unattractive, and exhibits two orifices, from one of which the animal can squirt water with considerable force. The internal structure is extremely beautiful and delicate. A great part of it consists of a large chamber, lined with a delicate membrane, over which the blood-vessels are widely distributed. The surface is abundantly covered with vibratile cilia; and, as the sea-water is freely admitted into the cavity, the ceaseless action of the cilia propels it in currents over the surface of the membrane, which thus performs the office of an internal gill. The chamber itself is hence appropriately termed the "branchial sac." Through it the nourishment of the animal must pass ere it can be received into the stomach, which is at

* Fig. 154.—*m*, Mouth.—*s*, Stomach.—*i*, Intestine.—*o*, Orifice.—*t*, Common Stem. The arrows indicate the direction of the currents of water subservient to respiration.

the lower extremity. On many occasions we have found specimens of a small crustacean* swimming about in the branchial cavity, and looked upon it as a parasite, established in its appropriate quarters, not as a casual occupant, destined, like some unfortunate wight in the fairy tale, as food for the Ogre into whose fortress it had intruded.

But although some species of Ascidia are rough and darkish, others of smaller size are possessed of glassy transparency, and, when kept alive in vessels of sea-water, furnish a spectacle of novelty and interest. Some of the compound species are branched (*Fig.* 154); and such is their transparency, that the movements of the internal organs can be distinctly seen. This has enabled Milne Edwards† to detect, in these animals, a very singular condition of the circulating system. The blood actually moves backwards and forwards, to and from the heart, in the same vessel, which thus performs the office both of a vein and of an artery, in the manner it was of old supposed to do in the human body. The young Ascidians are not fixed to the place of their birth, but gifted for a short period with locomotive powers, analogous to those of other marine animals already mentioned.

Some of these compound Ascidians are found arranged in regular radiating patterns on the fronds of our large sea-weeds. In such cases, the young, in its early state, has possessed a reproductive power by gemmation or buds, analogous to that of the larva of the medusa already mentioned (page 37). This fact, which has been established by Milne Edwards, explains the origin of the characteristic patterns which they sometimes exhibit on rocks washed by the waves, or on sea-weeds thrown upon the beach. These singularly-formed creatures (*Botrylli*) are, in their colours, gay and diversified, and their general aspect is such as would be presented by minute but brilliant medusæ, set with great regularity round a common centre.

Among the Tunicata are some (*Pyrosoma*) which are found in the open sea, especially in tropical climates, sometimes united together in masses of more than a mile in extent, and lighting up the sea by a beautiful pale greenish light, which passes with great rapidity into the other prismatic colours.

* *Notodelphys ascidicola.* For description and figure, vid. Professor Allman, in Annals of Natural History, vol. xx. July 20, 1847.

† Sur les Ascidies composees des cotes de la Manche. 1841.

A remarkable circumstance regarding the reproduction of some genera, is stated on the authority of Chamisso. The *Salpæ* (*Fig.* 155) are found linked together in long chains;



Fig. 155.—Biphora, one of the Salpæ.*

after a time their union is dissolved, and each individual propagates a solitary young one. This attains the full size of the species, and then brings forth a social chain of young *salpæ*, which again give origin to solitary individuals;—"so that a *salpa* mother," to use Chamisso's familiar expression, "is not like its daughter or its own mother, but resembles its grand-daughter and its grandmother."†

BRACHIOPODA.

These are bivalve Mollusca, and, like some of those just mentioned, are destitute of the power of locomotion. They are attached to foreign bodies, and are furnished with two long fringed arms (*Fig.* 156; hence the name of the class, "arm-footed." They are found abundantly in a fossil state. The species now existing are few in number, and some of them have been brought up from depths of from sixty to ninety fathoms. Mr. Owen, in reference to this circumstance, remarks, that both the respiration and nutrition of animals

* Fig. 155.—*a*, Mouth.—*f*, Liver, &c.—*b*, Branchial Sac.—*m*, Muscular Bands.—*h*, Heart.—*n*, Nervous Ganglion.

† Steenstrup on Alternation of Generations, page 39



Fig. 156.—Terebratula Psittacea.



Fig. 157.—Valve of the shell of Terebratula.

existing under the pressure of such a depth of sea-water "are subjects suggestive of interesting reflections, and lead one to contemplate with less surprise the great strength and complexity of some of the minutest parts of the frames of these diminutive creatures. In the unbroken stillness which must pervade those abysses, their existence must depend upon their power of exciting a perpetual current around them, in order to dissipate the water already laden with their effête particles, and to bring within the reach of their prehensile organs the animalcules adapted for their sustenance."* Some of these animals have been taken in deep water on the Irish coast, at Cork, Youghal, Kinsale, and the entrance to Belfast Bay.†

LAMELLIBRANCHIATA.

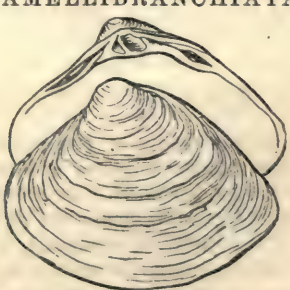


Fig. 158.—Mactra.

The third and last class of those Mollusks which are headless comprises those which have their gills in the form of mem-

* Lectures, page 279.

† W. Thompson, Report on the Invertebrate Fauna of Ireland.

branous plates; and, as the Latin word *lamella* means a plate, the compound term above employed denotes that structural peculiarity by which the class is distinguished. It includes the oyster, the scallop, the cockle, the mussel, and other well-known bivalves.

The sexes are distinct. The ova remain, for some time, in receptacles within the gills, which are thus made to perform the office of a marsupial sac; and here the young of some species, in their more advanced state, may be observed swimming freely about. The young of others anchor themselves, after exclusion from the parent, by means of silken filaments which are wanting in the mature individual, thus furnishing to the naturalist a beautiful example of "prospective design for the well-being of the weak and defenceless." *

The mouth of the oyster is situated near the hinge, beneath a kind of hood formed by the edges of the mantle (*Fig.* 159). But the question naturally arises, how is it supplied with food, the animal itself being utterly incapable of any active exertion for that purpose? We shall answer in the words of Professor Rymer Jones:—"Wonderful, indeed, is the elaborate mechanism employed to effect the double purpose of renewing the respired fluid and feeding the helpless inhabitants of these shells! Every filament of the branchial fringe, examined under a powerful microscope, is found to be covered with countless cilia in constant vibration, causing, by their united efforts, powerful and rapid currents, which, sweeping over the entire surface of the gills, hurry towards the mouth whatever floating animalcules or nutritious particles may be brought within the limits of their action, and thus bring streams of nutritive molecules to the very aperture through which they are conveyed to the stomach, the lips and labial fringes acting as sentinels to admit or refuse entrance, as the matter supplied may be of a wholesome or pernicious character."† Furnished with an apparatus so effectual, we can imagine that these animals realise the condition described by the poet; and,

> ——"In their pearly shells at ease, attend
> Moist nourishment."—MILTON.

If, however, while the oysters are thus lying "at ease," the

* Owen, pages 289, 290.
† Outline of the Animal Kingdom, page 378.

shadow of an approaching boat is thrown forward, so as to cover them, they close the valves of their shells before any undulation of the water can have reached them, thus showing they are sensible to changes of light.*

"The principal breeding season of the common oyster (*Fig.* 159) is in April and May, when they cast forth their

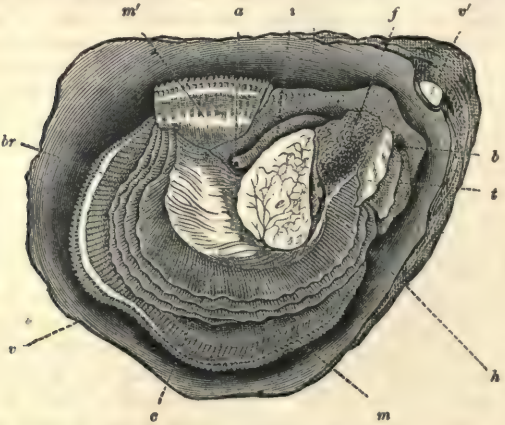


Fig. 159.—ANATOMY OF THE OYSTER.†

young in little masses like drops of grease, formed of several united together by an adhesive fluid, upon rocks, stones, or other hard substances that happen to be near; and to these the *spats*, as they are termed by fishermen, immediately adhere, soon forming a thin shelly covering. Very commonly they adhere to adult shells, and thus are formed the large masses termed *banks*. Their growth is very rapid. In three months they are larger than a shilling; and, at the end of the first year, they have a diameter of two inches."‡

Shakspeare has said, "Honesty dwells like a miser in a poor-house as your pearl in your foul oyster;" and the con-

* Owen, page 285.

† Fig. 159.—*v*, One of the valves of the shell.—*v'*, Hinge.—*m*, One of the lobes of the mantle.—*m'*, Portion of the other lobe folded back.—*c*, Adductor muscle.—*br*, Branchia, or gills.—*b*, Mouth.—*t*, Tentacula.—*f*, Liver.—*i*, Intestine.—*a*, Orifice.—*h*, heart.

‡ Carpenter's Zoology, vol. ii. page 398.

nexion of the oyster with the pearl is one of the interesting circumstances connected with its history. Moore, with his usual felicity, has referred to the Eastern fable of

> ——"That rain from the sky
> That turns into pearls as it falls in the sea."

The real facts, as at present known, are scarcely less wonderful. The shell is pierced by some worm, and the oyster deposits the "nacre," or mother-of-pearl, on the perforated part; or grains of sand or gravel gain admission into the substance of the mantle, and become encrusted by a similar deposit. This would appear to be, in many instances, the origin of the pearls, so highly prized, and still so eagerly sought for. The Romans were extravagantly fond of these ornaments, which they ranked next to the diamond, and are said to have given almost incredible prices for them. "Julius Cæsar presented Servilia, the mother of M. Brutus, with a pearl worth £48,417 10*s.*; and Cleopatra, at a feast with Antony, of which Pliny has given a long and interesting account, swallowed one dissolved in vinegar of the value of £80,729 3*s.* 4*d.*" Such statements are generally regarded by naturalists of the present day with distrust, as exaggerated or erroneous.



Fig. 160.—Pearl Oyster.

The shell (*Avicula margaritacea*, *Fig.* 160) from which the greater number of pearls and the largest quantity of mother-of-pearl is obtained, is not an oyster strictly so called, but belongs to an allied genus. It is not our intention to enter into any history of the pearl fisheries of Ceylon or the Persian Gulf, which annually give employment to some hundreds of boats and many thousand men. But we would mention, that a very exaggerated idea prevails as to the length of time a pearl-diver is in the habit of staying under water. The usual period on the Aripo banks, is stated by Captain Steuart, to be 53 to 57 seconds; when paid for the

effort they stay 84 or 87 seconds.* The depth is commonly from four and a half to eight fathoms. The entire amount of revenue derived from the pearl-fisheries of Ceylon, from March, 1828, to May, 1837, amounted, according to the same authority, to £227,131, but has decreased very considerably since that time.

The large Scallop, or, as it is called in the North of Ireland, the "Clam-shell" (*Pecten maximus*), can move rapidly through the water by striking the valves of the shell together, and thus propelling itself in the contrary direction. From their lively movements in the water, and the vigorous flappings of their brightly tinted valves, they have obtained the name of sea-butterflies.†

The common Mussel (*Mytilus edulis*) enjoys no such power of locomotion, being moored to its "bed" by the silken cable which it constructs for the purpose. This *byssus*, or, to use a more common term, this *beard*, of the Mussel, has been employed to assist in giving additional strength to works of human construction. At the town of Biddeford, in Devonshire, there is a long bridge of twenty-four arches across the Towridge river, near its junction with the Taw. At this bridge the tide flows so rapidly, that it cannot be kept in repair by mortar. The corporation, therefore, keep boats in employ to bring mussels to it, and the interstices of the bridge are filled by hand with these mussels. It is supported from being driven away by the tide entirely by the strong threads these mussels fix to the stonework; and by an act, or grant, it is a crime liable to transportation for any person to remove these mussels, unless in the presence and by the consent of the corporative trustees.‡

The Pinna, a bivalve already mentioned (page 84) excels any other in the quantity and fineness of its silk, "which has been woven into some articles of dress, that in early times were so highly prized as to be worn only by emperors and kings." At Taranto, in Italy, it is still mixed with about one-third of real silk, and made into gloves, caps, stockings, &c.

* Pearl Fisheries of Ceylon, by James Steuart, Master Attendant at Colombo, and formerly Inspector of Pearl Banks.—Printed at Ceylon, 1843.

† Owen. page 291.

‡ Daniel's Rural Sports, vol. ii. page 90.

of a beautiful brownish colour, valued as objects of curiosity, but too expensive for general use, the price of a pair of gloves on the spot being about six shillings, and that of a pair of stockings, eleven.*

But all the bivalves of this class are not destitute of organs specially adapted for locomotion. The "foot" of the common Cockle is an example of the contrary. By means of this instrument, the animal can, with ease, bury itself in the sand. In some of those bivalves the creature excavates its dwelling in mud, and, furnished with a tubular apparatus, thus keeps up its communication with the water above, and feels no want of either respiration or nourishment. The foot, in its structure, "almost exactly resembles the tongue of a quadruped, being entirely made up of layers of muscles crossing each other at various angles; the external layers being circular or oblique in their disposition, while the internal strata are disposed longitudinally."†

Perhaps this is the place where we may best direct the attention of the reader to the vast importance of the marine Mollusca of our coast, as an article of food. As such they find their way into the dwellings of the rich, and are prized as a cheap and wholesome article of diet in the cabins of the poor. If it were possible to obtain from each locality some tabular returns of the number of persons employed in collecting "shell-fish," to use the common appellation, and of the average weight which each individual procured, we doubt not that the result would be so great as to excite astonishment. While residing, in July, 1837, near the town of Larne, County Antrim, we endeavoured to form some calculation of the quantity of the common Limpet taken from the rocks about that part of the coast, and used as food, and had reason to believe that the weight of the boiled "fish" was above eleven tons.‡ The weight, as carried from the beach, was, however, much greater, as there is to be added that of the shell, and of a small quantity of sea-water which it contained. Whelks or Periwinkles (*Turbo littoreus*, Linn.) were also collected at the same time; and thus made the probable weight of these two kinds of shell-fish as taken from one locality, in a single

* Dr. Johnston. Mag. Nat. Hist. vol. iii. page 257.

† Jones's Outline, page 381.

‡ *Vide* paper "On the Common Limpet as an Article of Food." Annals Nat. Hist. vol. iii. June, 1839.

season, not less than forty tons. This must, however, be greater than the average of ordinary seasons, when causes connected with the scarcity or high price of provisions, which then prevailed, are not in operation. But after every such allowance has been made, the quantity used as food is very considerable. This is attested in other localities round the coast, by the large heaps of shells which may be seen about the dwellings of the humbler classes.

The entrance to the Bay of Belfast, and the loughs of Strangford and Carlingford, furnish a valuable supply of oysters, which are conveyed for sale to considerable distances. The Carrickfergus oysters are large in size, and so much in demand, that their price in the Belfast market is generally from twelve to fifteen shillings per hundred of 120 oysters. It is occasionally 20*s.*; and we have known one instance in which so much as 30*s.* was paid. The price of the pearl oysters,* when landed on the beach at Condatchy, varies from 14*s.* to £6 per thousand; so that the best edible oysters are sold in these countries at more than the pearl oysters at Ceylon.

It is interesting to the botanist, in passing over moor, and mountain, and valley, to observe the kind of plants which are found in each of these situations, and which could not thrive, or perhaps could not live, if removed to any of the others. A similar pleasure awaits the zoologist, who, in his progress round the coast, notes how the species of marine animals which are abundant in one district have disappeared as the coast changes its character, and have their place supplied by species altogether different, but suited to the nature of the locality where they are found. Thus the coast, both to the north and to the south of Belfast Bay, is rocky, and Limpets are, accordingly, plentiful. Within the bay, and opposite to the village of Holywood,† are extensive mud banks, which,

* Steuart on the Pearl Fisheries at Ceylon.

† An old inhabitant of that village has favoured us with the following particulars:—

"The year 1792 or 1793 was remarkable for the great drought that prevailed, and the distress consequent upon it. In the month of June or July, that year, about twenty families of poor people came from the interior of the country, and encamped along the road side and on the beach, a short way to the west of Holywood. They remained there about five weeks, during which they subsisted partly on such vegetable food as they were able to pick up about the hedge-rows and fences, but principally upon the mussels which are so abundant on 'the bank,' about

towards their outer edges, are the chosen residence of millions of mussels, forming continuous beds, from which the people of the village procure an abundant supply, and where boats are sometimes filled with mussels for the Belfast market. By crossing the narrow neck of land which separates the loughs of Belfast and Strangford, we come at once upon a wide extended beach of sand. Here the Limpets have disappeared—the Mussels abound no longer, and their place is more than supplied by multitudes of the common Cockle, which alike furnish food and occupation.



Fig. 161. TEREDO.

Among the Mollusks of the present class, are those which possess the art of boring into hard substances, and living in the excavation thus formed. We have dug out of indurated clay, so hard as to make our progress in it a work of labour, perforating bivalves of two genera (*Pholas* and *Venerupis*). Some even bore into the solid limestone rock, and the piers and breakwater at Plymouth, which are formed of this material, bear evidence of their powers. Perhaps none of these animals is so noted for its ravages as the *Teredo* (*Fig.* 161), which Linnæus emphatically termed "calamitas navium." "They are now common in all the seas of Europe, and, being gifted with the power of perforating wood, they have done, and continue to do, extensive mischief to ships, piers, and all submarine wooden buildings. The soundest and hardest oak cannot resist them; but in the course of four or five years they will so drill it as to render its removal necessary, as has happened in the dockyard of Plymouth. In the year 1731 and 1732, the United Provinces were under a dreadful alarm, for it was discovered that these worms had made such depredations on the piles which support the banks of Zealand, as to threaten them with total destruction, and to claim

half a mile distant. No instance of disease from this diet occurred; and, during that summer, the poorer classes in the village appeared quite as healthy as in other years, though mussels formed the chief part of their food."

from man what he had wrested from the ocean. Fortunately, they, a few years after, totally abandoned that island, from causes unknown, but suspected to be from their not being able to live in that latitude when the winter was rather severer than usual."*

Owing to the general use of metal sheathing, the Teredo is now nearly extinct on the British coast. The last account of its ravages was one in 1834, relative to the injury it had caused to the piers of Portpatrick, in Wigtonshire.†

It is occasionally the pleasing duty of the naturalist to direct attention to some of the many examples where there springs from "partial evil, universal good;" and perhaps the Teredo, notwithstanding the evidence of its destructive powers, might, if the whole truth were known, be ranked among the number of our benefactors. Mr. R. Ball has remarked to us, "that but for the maligned Teredo, the sea would be so covered with floating logs of timber, as to be to some extent unnavigable; that the rivers of warm latitudes would be choked up by the accumulated driftwood at their mouths, and that their fertile banks would, in many cases, be converted into morasses."

On one occasion, on our northern coast, a piece of the carved and painted woodwork of some unfortunate vessel was flung up by the waves as we strolled along the beach, and never shall we forget the interest with which we examined the numerous perforations of the Teredo. The animals were still living in the galleries which they had excavated, and which were lined, throughout all their windings, with a smooth, white, shelly secretion. While all had applied with effect the curious auger-shaped valves by which their perforations are made, none had interfered with the progress of his fellows. Almost in every instance, when the borings approached too close, their direction had been changed, and contact thus avoided. It was strange to look upon this piece of drift timber, the sport of the wind and waves, and reflect upon the little world of animated existence it contained, and the skill and perfection shown in the structure of their sea-borne dwellings.

* Dr. Johnston, in 1829. Mag. Nat. Hist. vol. ii. page 23.

† Wm. Thompson, in Edinburgh New Phil. Journal. Jan. 1835. The same gentleman has since recorded in Annals of Nat. History, Sept. 1847, its occurrence at Ardrossan, Ayrshire.

We now proceed to notice, with equal brevity, some of the best known examples of the different classes of the *encephalous* Mollusca, or those which have a distinct head. The classes, as already mentioned (page 162), are three in number.

I.—PTEROPODA.

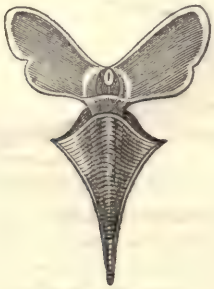


Fig. 162.—Hyalæa.

The little Mollusks belonging to this order are furnished with two membranous expansions, like fins or wings (*Fig.* 162), and hence the compound term, which signifies "wing-footed," points out the obvious distinguishing characteristic of the class.

There are several genera, but the species best known (*Clio borealis*) is about an inch in length, and so abundant in the Arctic seas as at times to colour the surface for leagues, and to form an important supply of food to the great whale. Our knowledge of its structure is principally derived from the researches of Professor Eschricht, of Copenhagen. The head is furnished with six retractile appendages, which are of a reddish tint from the number of distinct red spots distributed over their surface, and amounting on each to about 3,000.* When examined under a high magnifying power, each of these specks is found to consist of about twenty suckers, each mounted on a footstalk, so as to be projected beyond the edge of their sheath, and applied to their prey. "Thus, to use

* *Vide* Owen, page 293; Carpenter, p. 359; Jones, p. 425.

the words of Professor Jones, "There will be (3,000 × 20 × 6) 360,000 of these microscopic suckers upon the head of one *Clio;* an apparatus for prehension perhaps unparalleled in the creation."

II.—GASTEROPODA.

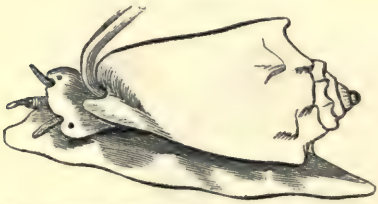


Fig. 163.—VOLUTE (THE ANIMAL REPRESENTED IN MOTION).

IF we look at the common Snail, as it crawls along, we notice that the only organ it possesses as a substitute for legs is a broad muscular disc, forming the lower surface of the body. Hence the compound term *Gasteropoda* (belly-footed) indicates the peculiarity of its locomotive structure, and is used as the name of the class in which a similar structure prevails (*Figs.* 147, 153, 163).

The class is extremely numerous, and is conveniently distributed into orders distinguished by modifications of their respiratory organs.* Into any minute details of these structural

* It may be convenient to enumerate, in one place, the orders into which the class is divided, accompanied by an explanation of the scientific names.

Nudibranchiata	gills naked.
Inferobranchiata	gills inferior or lower.
Cyclobranchiata	gills round the body.
Tectibranchiata	gills covered by mantle.
Pulmonata	breathing by lungs.
Scutibranchiata	gills with a shield.
Tubulibranchiata	gills with a tube.
Pectinibranchiata	gills like a comb.

The order last mentioned is the highest in point of organization; in it the sexes are distinct.

characteristics it is not our intention to enter; still less do we purpose giving any enumeration of the genera into which the several orders are subdivided. We shall merely endeavour to convey some idea of the principles on which the classification is conducted, and relate some particulars with regard to the habits, structure, or uses of a few well-known species.

In two orders the animals are all marine, and are destitute of any shelly covering. In that to which the term *Nudibranchiata* is applied, the gills are also naked or unprotected, and are arranged in various forms, and attached to different parts of the body. The animals are found upon the rocks and seaweeds on our shore, and floating with the foot uppermost, on the smooth surface of our bays; they are also dredged up from considerable depths. When placed in sea-water, they exhibit figures of great delicacy, variety, and elegance, and with a beautiful diversity of colouring. Their size is very different, some of our native species being less than half an inch in length, while others measure so much as four inches.* The eggs of many are in the form of a delicate spiral ribbon-shaped coil, and are attached to stones near the shore or to corals in deep sea-water, according to the habits of the species.† Some gaily-coloured members of this group are found in the Mediterranean and the Indian seas, and swim with great rapidity.



Fig. 164.—Eolis.

The common Limpet forms an example of a Mollusk of a different order, in which the gills extend like a fringe round the lower edge of the body, and between the body and the foot (*Cyclobranchiata*). Those who see the Limpet only when left uncovered by the tide have no idea of the ease with which it can march about when the returning waters once more surround its dwelling. Its little excursions are not, however, "idlesse all;" they are undertaken for the important

* R. Ball. *Vide* W. Thompson, on Mollusca of Ireland, in Annals of Nat. Hist. 1840.

† *Vide* an elaborate Monograph on the British Species of Nudibranchiate Mollusca, by Messrs. Alder and Hancock, now in course of publication by the Ray Society. It is illustrated with figures of exquisite delicacy.

object of procuring food. This consists of sea-weeds of different kinds, which it rasps down by means of a ribbon-shaped instrument longer than its entire body, and covered with minute recurved hooks. The first time we chanced to

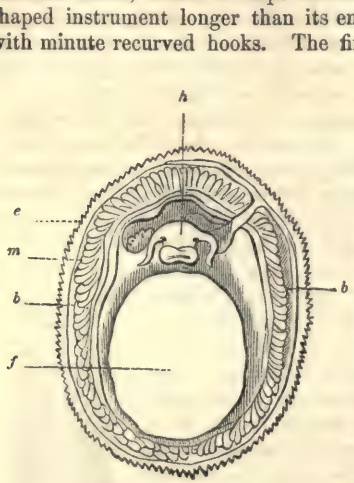


Fig. 165.—Limpet.*



Fig. 166.—Chiton.

see this, we mistook it for some strange species of worm: but, on examining several Limpets, the supposed worm was seen in all; and great was our astonishment when we discovered that we had, in every case, been looking at the *tongue* of the Limpet, and not at any intruder into the privacy of his conical fortress.

The shell of the Limpet consists of one piece; but in the *Chiton* (*Fig.* 166), an allied genus found near low water mark, and under stones, the shell is composed of a number of distinct plates. These are so arranged that the edges overlap like the slates of a house, and the ligaments possess such flexibility, that the shell can, at the pleasure of the animal, be rolled into a ball.

That order which is characterised by having the gills concealed under a fold of the mantle (*Tectibranchiata*) may be illustrated by reference to a creature not uncommon on our shores, the Aplysia or Sea-hare, the *Lepus marinus* of the

* Fig. 165.—The animal of the Limpet, as seen from below.—*h*, Head.—*e*, Edge of shell.—*m*, Mantle.—*b*, Branchiæ.—*f*, Foot.

ancients (*Fig.* 167). The first which our dredge brought up was placed on one of the rowing benches of the boat, and emitted a rich purplish fluid so copiously that it ran along the

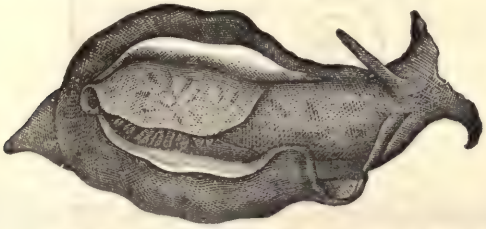


Fig. 167.—Aplysia.

board. Being transferred to a phial of sea-water, the purple dye was still given off in such abundance that the creature soon became indiscernible. It was not until the water was changed that we had the opportunity of observing the ease and grace with which it moved about, elevating and depressing its mantle, altering the outline of its body, and extending and retracting its tentacula so incessantly, that an artist would have found a difficulty in catching its characteristic figure. It is probable that the form of the upper pair of tentacula suggested the idea of the ears of the hare, and thus gave origin to its common title. The body of this species (*A. depilans*) was marked with numerous brownish spots, of irregular size and form; but when the animal died and the body was placed in spirits, the beautiful spotted epidermis disappeared off the larger portion. This creature, it was once believed, held such antipathy to man that its touch would cause the hair to fall off; and it also was said to supply a poison, the operation of which was speedy and inevitable. Time has stripped this inoffensive creature of these imaginary powers.

Of the tribes which breathe by lungs (*Pulmonata*) the common Slugs and Snails offer familiar examples. Even of these species, which are aquatic, many come to the surface for respiration, and float or move with the back downwards. "On a Summer's day," says Dr. Johnston,* "any one may

* Mag. Nat. Hist vol. iii. page 531.

see the Lymnæa and Planorbes (*Figs.* 147, 168) thus

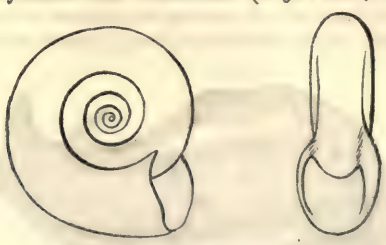


Fig. 168.—PLANORBIS.

traversing the surface of ponds and ditches, in an easy undulating line, or suspended there in luxurious repose, perhaps

> "To taste the freshness of heaven's breath, and feel
> That light is pleasant, and the sunbeam warm."

The soft skin of those species which are unprotected with shells might naturally be supposed to be possessed of great sensibility, but such does not appear to be the case. "Baron Férussac, for example, states that he has seen the terrestrial Gasteropods or slugs allow their skins to be eaten by others, and, in spite of large wounds thus produced, show no sign of pain."* They possess, in a high degree, the power of repairing injuries and of reproducing lost parts. Many species, in their young state, can suspend themselves from any object by means of a thread emitted for the purpose, and in some this thread-producing power continues during life.† Those who have not examined the internal structure of these animals may perhaps be surprised to learn that in each there exists a small rudimental shell. If we are asked "what is the use of it?" we can only answer, "we cannot tell;" but, in many other animals, we can point to a rudimental structure apparently of no use in the organization of a certain species, yet, in others with which it is nearly allied, becoming, in its full development, of great importance to the economy and habits of the animal.

Thus, in the present case, though we find only a rudimental shell in the Slug (*Limax*), we meet with a conspicuous external covering of shell in the Snail (*Helix*). The species belonging to the latter family (*Helicidæ*) are very numerous,

* Quoted by Owen, page 306.

† Rev. B. J. Clarke, on the Irish species of the Genus *Limax*. Annals Nat. Hist. vol. xii. page 341.

no less than forty being known in Ireland alone.* In a little wooded glen, we have, in a couple of hours, collected more than a dozen of species, some of them, though minute, of great beauty when examined under the microscope. The larger species afford a plentiful supply of food to two of our favourite songsters, the blackbird and the thrush. Those with thin shells are, of course, the most in request, and are brought to some flat stone, and there broken to pieces. We recollect how tantalising, on one occasion, it seemed, when searching with a friend for a very elegant native species, which is found in wooded districts (*H. arbustorum*), while the shells we discovered were "few and far between," the recent fragments strewed plentifully about the stones, used by the thrushes for their demolition, showed that the birds were much more successful in their search than the naturalists.

About the sandy slopes and hillocks which extend for considerable distances along the coast, several creatures of this family may be found; and he who examines them critically will notice that, although the habitat appears of the same character, species will be abundant in one locality which are wanting in another, and their presence or absence does not seem to depend upon any law of geographical distribution. How constantly do the phenomena of nature make us feel the limited extent of our knowledge, and say, in a manner not to be misunderstood, "Be humble!" It is a general belief that these little snails are eaten, in vast numbers, by the sheep which graze upon the scanty pasturage of the sandy knolls, and that they form a very fattening kind of food.

The *Helices* are not, however, used only as food for birds, or for sheep and other quadrupeds, such as the hedgehog. There is a species, found in the southern and midland counties of England, which has been considered a delicacy by man himself (*H. Pomatia*). "From the time of the Romans, who fattened them as an article of food, they have been eaten by several European nations, dressed in various ways. Petronius Arbiter twice mentions them as served up at the feast of Trimalchio (Nero), first fried, and again grilled on a silver gridiron. At one time, it seems, they were admitted at our own tables; and Lister, in his *Historia Animalium Angliæ*, p. 111, tells us the manner in which they were cooked in his time. They are

* W. Thompson. Report of British Association, 1843.

boiled in spring-water, and when seasoned with oil, salt, and pepper, make a dainty dish."*

Fig. 169 represents a species belonging to a different order

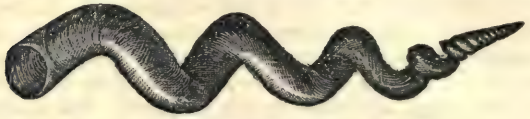


Fig. 169.—Vermetus.

(*Tubulibranchiata*). Such shells occur in groups, and are always found attached to other bodies. They bear some resemblance to the tubes of the serpulæ (*Fig.* 40), though the contained animals are widely different.

Of those which possess comb-shaped gills (*Pectinibranchiata*) the common Whelk, or, to use the term employed in the North of Ireland, the "Buckie" (*Buccinum undatum*) is perhaps the best known example. It is carnivorous in its habits, and is furnished with a singular kind of proboscis, well adapted for boring into the shells of other Mollusks. On some parts of the Irish coast it is taken in wicker baskets containing offal, and is then extensively employed by the fishermen as bait. From its abundance and its size, it is very frequently used by children in the manner described in the exquisite lines of Wordsworth:—

> ——————————"I have seen
> A curious child applying to his ear
> The convolutions of a smooth-lipped shell,
> To which, in silence hushed, his very soul
> Listened intensely, and his countenance soon
> Brightened with joy; for murmuring from within
> Were heard sonorous cadences, whereby,
> To his belief, the monitor express'd
> Mysterious union with its native sea.
> Even such a shell the universe itself
> Is to the ear of faith, and doth impart
> Authentic tidings of invisible things;
> Of ebb and flow, and ever-during power;
> And central peace subsisting at the heart
> Of endless agitation."

Another shell, even more plentiful on our rocky shores, is the Dog-whelk (*Purpura lapillus*). It is remarkable for furnishing a purplish dye, which makes an indelible marking-ink. This is contained in a whitish or straw-coloured vein,

* Turton's Manual, edited by John Ed. Gray, pages 135, 136.

close to the head, and when applied to white linen when the sun is bright, is first green, then blue, changing to a reddish tint, and finally purple. It is not, however, to be supposed that this fluid is identical with that dye for which Tyre was so celebrated when its "merchants were princes, and its traffickers the honourable of the earth;" and which was reserved for the brilliant hangings of temples, or the costly robes of priests and kings. By what species of shell this dye was produced, and how it was extracted, have been questions respecting which much difference of opinion has prevailed. Our latest information on the subject is derived from Mr. Wilde,* who, when visiting the ruins of Tyre, in 1838, found on the shore "a number of round holes cut in the solid sandstone rock, varying in size from that of an ordinary metal pot to that of a large boiler." Within these, and on the adjacent beach, he found large quantities of shells broken, apparently by design, but subsequently agglutinated together. Hence he inferred, that the shells had been collected, in large masses, into these holes or mortars, to be pounded in the manner mentioned by Pliny, for the purpose of extracting the fluid which the animal contained. This opinion received confirmation from his finding that the broken shells of this conglomerate proved, on examination, to be the *Murex trunculus*, one of the species from which the Tyrian dye is known to have been obtained; and, also, that several of the recent shells, exactly agreeing with these, were found on the adjoining beach. The genus contains shells of great beauty (*Fig.* 170), some of which are furnished with long and delicate spines.

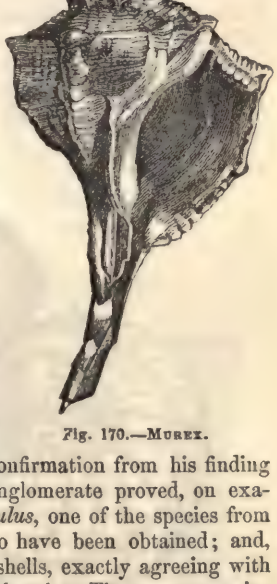


Fig. 170.—Murex.

* Narrative of a Voyage to Madeira, Teneriffe, &c. 2d edition, page 378; and Appendix to the same work, page 629.

III.—CEPHALOPODA—CUTTLE-FISHES.



Fig. 171.—Calamary.

If we look at a Cuttle-fish (*Fig.* 171), we notice that the head is surrounded by a number of appendages; and this peculiarity is implied in the term "*Cephalopoda.*"* It is restricted to the third division of the encephalous Mollusca; to that class which is the most elevated in organization. Its superiority is manifested in the muscular, the respiratory, and the nervous systems, and also in the existence of a true internal skeleton of a peculiar structure, the first approach towards the most obvious characteristic of the vertebrate animals.

Though the shell of the Pearly Nautilus (*Nautilus Pompilius*, *Fig.* 172) is common in museums, the capture of the

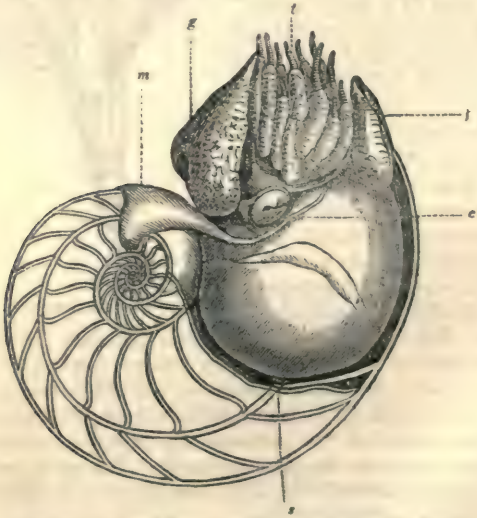


Fig. 172.—Pearly Nautilus, with the shell laid open.

Fig. 172.—*t*, Tentacula.—*f*, Funnel.—*g*, Foot.—*m*, Part of mantle.—*e*, Eye.—*s*, Siphon.

* From two Greek words, signifying *head-feet.*

living animal is of rare occurrence. One was taken, when floating in the South Seas, and being presented to the College of Surgeons, London, was there dissected by Professor Owen, who published an elaborate memoir on its structure, and its relations to other families, both recent and extinct. We learn from this source that it has four gills (*Tetrabranchiata*), in which respect it differs from all other existing species of Cuttle-fish, that it occupies the outer chamber of its shell, and that it can rise to the surface or descend at pleasure. Similar in structure and in powers were the Ammonites (*Figs.* 173, 174), which at former periods of the earth's history,



Fig. 173.



Fig. 174.

AMMONITES.

must have been living in its seas, though now known only as fossil; and alike in general organization, though different in form, are those large tapering chambered fossils (*Orthoceratites*) which, in some parts of Ireland, are so abundant in the limestone quarries.

The other Cuttle-fishes (*Dibranchiata*) abound in all seas, and are arranged in two divisions, according as they have eight or ten arms. To the latter group belong the Loligo or Calamary (*Fig.* 171)—the common Sepia or Cuttle-fish—and the Loligopsis (*Fig.* 175), so remarkable for the great length of one pair of its arms. All possess a shell or internal skeleton differing in form and structure in different species; all are furnished with a powerful horny beak for tearing up their prey, and with an ink-bag, from which, at pleasure, they can emit a fluid which darkens the water and favours their escape from their enemies.



Fig. 176.
BELEMNITE.

To this division belonged the Belemnite (*Fig.* 176), whose remains are abundant in the white limestone of the County

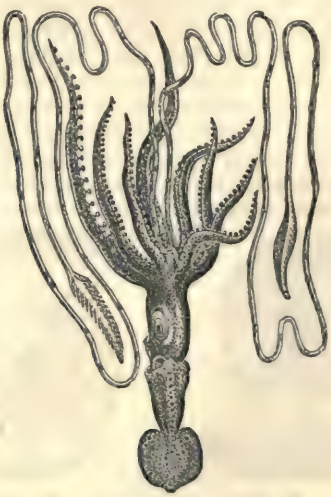


Fig. 175.—Loligopsis.

Antrim. The flinty conical body we now behold constituted part of the internal skeleton of the living animal. The remains of a Belemnite have been found in England in such a state of preservation as to show the head, the arms, the ink-bag, and the internal shell.* From a careful examination of its structure, Mr. Owen is of opinion that it possessed the power of swimming backward and forward with great vigour and precision, could rise swiftly and stealthily to infix its claws into the belly of a fish, and then perhaps as swiftly dart down, drag its prey to the bottom, and devour it. How strange it is to gaze upon that fossil entombed in masses of limestone, and, in imagination, picture that flinty structure gifted with life, and forming part of a carnivorous animal, who, in the primæval seas, ere these lands were upheaved from the bed of ocean, carried on his career of rapine, the voracious destroyer of the weaker inhabitants of the deep!

* Owen, pages 337, 339.



Fig. 177.—Argonaut, or Paper Nautilus.

Of the eight-armed division, the most interesting species is the Argonaut or Paper Nautilus, regarded as giving to man the first example of the art of navigation. It has been usually represented as in the annexed figure (*Fig.* 177), with six arms extended over the sides of its little vessel to act as oars, and two others upraised as sails. Such being the universal belief among naturalists, it is to be expected that

poets would not fail to celebrate its nautical capabilities.* Thus, Pope bid us

> "Learn of the little Nautilus to sail,
> Spread the thin oar and catch the driving gale."

And Montgomery, in his "Pelican Island," gives a picture so exquisitely finished, that even the naturalist can scarcely bring himself to wish that it were different:—

> "Light as a flake of foam upon the wind,
> Keel upward from the deep emerged a shell,
> Shaped like the moon ere half her horn is fill'd;
> Fraught with young life, it righted as it rose,
> And moved at will along the yielding water.
> The native pilot of this little bark
> Put out a tier of oars on either side,
> Spread to the wafting breeze a twofold sail,
> And mounted up and glided down the billow
> In happy freedom, pleased to feel the air,
> And wander in the luxury of light."

It is now ascertained that the Nautilus never moves in the manner here described. The account, though so universally accredited, is altogether fabulous. It moves backwards through the water by the action of its arms, like other Cuttle-fish. It can creep along the bottom, and, like many other Mollusks, it can rise to the surface; but there, the arms are never employed as oars. Nor are those which have the broad expanded membranous disc ever used as sails; their true function, as ascertained by M. Rang, and confirmed by the experiments of Madame Power, is the secretion of the substance of the shell. They are stretched tensely over its surface, and, when accidental injuries arise, they deposit for its repair the needful quantity of shelly matter. To do this, and to supply what is wanted for the enlargement of the shell with the growth of the animal, is their appointed duty; one similar to that of the mantle of the bivalve shells.

* Byron's well-known description is too beautiful to be omitted:—

> "The tender Nautilus who steers his prow,
> The sea-born sailor of his shell canoe,
> The ocean Mab, the fairy of the sea,
> Seems far less fragile, and, alas! more free.
> He, when the lightning-wing'd tornados sweep
> The surge, is safe—his port is in the deep—
> And triumphs o'er the armadas of mankind,
> Which shake the world, yet crumble in the wind."
>
> THE ISLAND.

The species of Octopus (*O. vulgaris, Fig.* 178) found on the British shores, and known as the common *Poulpe*, is of rare occurrence on the Irish coast.* Its strange figure and staring eyes cannot fail to excite astonishment when seen for the first time, more especially when its twisting arms are

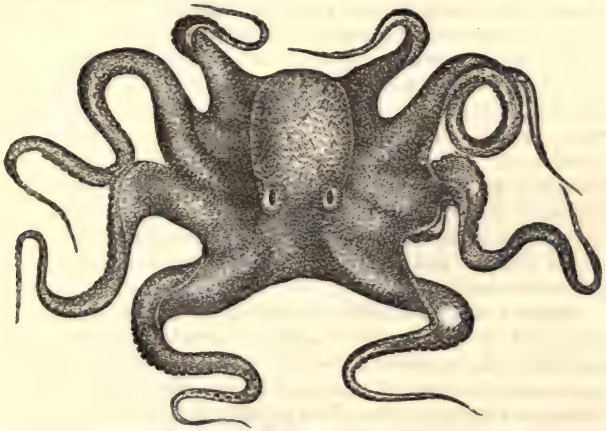


Fig. 178.—Octopus or Poulpe.

employed in the act of walking, or in that of swimming, by means of the contractions of their connecting membrane. These arms have, however, another office, for which they are elaborately adapted; and as the description given of them by Professor Jones is equally applicable to other Cephalopods, we shall adopt the language of that eloquent writer:—

"The feet or tentacula appended to the head are not, however, exclusively destined to effect locomotion; they are used, if required, as agents in seizing prey, and of so terrible a character, that armed with these formidable organs, the Poulpe becomes one of the most destructive inhabitants of the sea; for neither superior strength nor activity, nor even defensive armour, is sufficient to save its victims from the ruthless ferocity of such a foe. A hundred and twenty pair of suckers, more perfect and efficacious than the cupping-glasses of human contrivance, crowd the lower surface of every one of the eight flexible arms. If the Poulpe but touch its prey, it is enough;

* Another species (*Eledone ventricosa*) takes its place, and often its name.—R. Ball.

once a few of these tenacious suckers get firm hold, the swiftness of the fish is unavailing, as it is soon trammelled on all sides by the firmly-holding tentacula, and dragged to the mouth of its destroyer. The shell of the lobster or crab is a vain protection, for the hard and crooked beak of the Cephalopod easily breaks to pieces the frail armour." *

An instance of its powers, both of attack and escape, fell under the observation of Mr. Broderip, of London. He attempted, "with a hand-net, to catch an Octopus that was floating within sight, with its long and flexible arms entwined round a fish, which it was tearing to pieces with its sharp hawk's-bill. The Cephalopod allowed the net to approach within a short distance of it before it relinquished its prey, when, in an instant, it relaxed its thousand suckers, exploded its inky ammunition, and rapidly retreated, under cover of the cloud which it had occasioned, by rapid and vigorous strokes of its circular web." †

Besides the power of thus escaping when pursued, it also possesses, in common with others of its class, a protection against being discovered, which, conjoined with the other, surpasses the cloak of darkness in the fairy tale. It can change its colour to that of the adjacent objects; so that, like the Ptarmigan in the snow, it becomes comparatively inconspicuous. Mr. Owen remarks, that "the power which the Cephalopods possess of changing their colour, and of harmonizing it with that of the surface on which they rest, is at least as striking and extensive as in the Chameleon, in which it seems, from the latest observations, to be produced by a similar property and arrangement of pigmental cells." ‡

The prepared ink of the Cuttle-fish is capable of being made into a pigment, and, even after being entombed for centuries, preserves its powers. Dr. Buckland supplied some of this fossil ink to an eminent painter, who immediately inquired from what colour-man such excellent sepia might be procured. The internal bone is used in making erasures, and is manufactured into the article known as "pounce" in the shops. The flesh, especially that of the arms, is considered very nutritious. It was highly prized by the ancients, and, though not used in these countries, is still much sought for in other

* Outline of the Animal Kingdom, page 431.
† Owen, page 346. ‡ Page 343.

parts of the world, and occasionally exposed for sale in the market at Naples and elsewhere. Our most common species (*Loligo vulgaris*) forms the bait with which one-half of the cod taken at Newfoundland is caught.* During violent gales of wind, hundreds of tons of them are thrown up there on the beach. Other species appear elsewhere to be no less numerous. Mr. Bennett† describes them as forming a dense shoal on the surface of the water, extending several hundred yards on each side of the ship he was in; and also gives an animated description of the flights of the flying squid, a name given to another species because of their manner of leaping from the water.

Stories are told of gigantic Cuttle-fish throwing their arms over luckless vessels, the thickness of each arm being equal to that of the mizen-mast. But it is the business of science to dispel these exaggerations, and patiently and laboriously to seek out the truth, hailing with joy each new light which may shine on the subject of inquiry. In the College of Surgeons, London, are preserved portions of the largest specimen of a Cuttle-fish which any of our museums contain. The carcass was found during Captain Cook's first voyage, floating on the sea, surrounded by aquatic birds, who were feeding on its remains. "Comparing the size of this animal, from the parts existing, with that of the smaller perfect animals, its body must have been at least four feet long, which, added to the tentacula, would make it seven feet in length."‡ We have, in these countries, no positive evidence of the existence of any Cuttle-fish of larger dimensions, but the general prevalence of such belief inclines naturalists at present not to deny the possibility of their occurrence.

The ova of the Cuttle-fish are contained in vesicles, which, in some cases, are clustered together, and known as "sea-grapes." On one occasion, our dredge brought up a large mass of them, so mature that, in the act of throwing it into a vessel of sea-water, many of the ovisacs burst, and, to our astonishment, we beheld the fluid swarming with minute Cuttle-fish, whose dark eyes were singularly conspicuous. In April, 1845, we found, on a sandy bank, in Belfast bay, a number of detached vesicles, which had been left uncovered

* Dr. Johnston in Mag. Nat. Hist. vol. iii. page 153.
† Narrative of a Whaling Voyage round the Globe. London, 1840.
‡ Owen, vid. Athenæum, 1840, page 676.

by the retiring tide. Each had a thread-like extremity, buried in the sand to the depth of two or three inches, and highly elastic. We have been unable to ascertain to what kind of Cuttle-fish they belonged.* Mr. R. Ball has recorded, as occurring in the Irish seas, twelve species of Cephalopoda, three of which were previously undescribed.†

The remains of animals of this family have been found along with the undigested portions of the food of the gigantic saurian reptiles of remote ages; and thus, in the words of Dr. Buckland, "the general law of nature, which bids to eat and be eaten in their turn, is shown to have been co-extensive with animal existence on our globe; the *carnivora* in each period of the world's history fulfilling their destined office, to check excess in the progress of life, and maintain the balance of creation."

The brief space devoted to the Mollusca cannot be closed without adverting to their great importance in a geological point of view. Their shells, which, in a fossil state, are found in the secondary rocks, are different from those of any animals of the same tribes now existing. They may belong to the same families, in some cases to the same genera, but *invariably the species is extinct.* In the older tertiary rocks, we meet, for the first time, with shells in a fossil state, which are specifically identical with some now living. But the number of such is so small, that it has been estimated at only three and a half per cent. of the entire. As we approach the more recent strata, the number of shells of species still living continues to increase, until, in those tertiary rocks which are the most recent, it constitutes nine-tenths of the entire number. Hence shells have, with great propriety, been termed "the medals principally employed by Nature in recording the chronology of past events." ‡

An aid in the detection of generic resemblances between different fossil shells, and also between recent and fossil, has

* They have so much resemblance to the ovisacs contained in the ovary of *Rossia palpetrosa*, figured by Professor Owen in the appendix to Ross's voyage, that we are inclined to surmise they must have been those of some species of the same genus—a conjecture the more probable as to this genus belong two species, added to our Fauna by Mr. Ball. Ovisacs described to us as similar to what we have noticed were found by Miss Ball on Clontarf strand.

† Proceedings Royal Irish Academy, 10th Jan. 1842.

‡ Lyell's Principles of Geology, vol. i. page 283.

of late been afforded by the microscopic investigation of their structure by Dr. Carpenter, an investigation which is still in progress. That gentleman observes, "that marked differences in the structure of shell go along with marked difference in general characters, and that a close correspondence in the structure of the shell may be held to indicate a tolerably close natural affinity."* And he enumerates certain genera "which may be at once distinguished from each other, and from all other shells, by the characters supplied by a fragment of shell which a pin's head would cover." Should more extended observations warrant the broad inferences to which such inquiries at present point, and be found applicable to the Crustacea and Echinodermata, no less than to the Testacea, how clear is the light which they will cast into "the palpable obscure," which sometimes baffles the most anxious and persevering efforts of the geologist!

Another series of observations, of a nature totally unlike these, has given additional importance to the shells of stratified rocks, by teaching us better to understand the circumstances under which they have been originally deposited. These investigations were carried on by Professor Edward Forbes,† in the Ægean Sea, on board H. M. S. *Beacon*, Captain Graves, and continued for eighteen months. By means of the dredge, the Mollusca and Radiata of that region were explored, at all depths of water between the surface and 230 fathoms. Nearly 700 species were thus found, and, in different regions of depth, they were associated in such a manner that each of these regions presented its own peculiar and characteristic association of species, just as on lofty mountains the character of the vegetation changes in proportion to the altitude. Those species which had the widest range of geographical distribution, had also the most extensive range with regard to regions of depth; and some were discovered living, which had previously been known only as fossil. Both with regard to vegetable and animal life, species were found to attain, at certain depths, a maximum size, then gradually to diminish, and finally to disappear, their places being supplied by similar forms, specifically distinct. Genera, in like manner, were found to be replaced by corresponding genera. So that the

* Annals Nat. Hist. December, 1843.
† Report to British Association. Cork meeting, 1843.

exploration of this sea exhibited, in regard to depth, a series of phenomena similar to what had been already observed by geologists with regard to successive periods of time, or to degrees of latitude in geographical distribution; thus showing that the study of the characters which Nature now exhibits furnishes the key to that series of ciphers in which she has written the history of the past.

It will be seen, therefore, that, in the study of the Testacea, the naturalist rises from the determination of species to inductions which lead him to examine the structure, habits, and distribution of extensive groups; to investigate the conditions under which they are found to exist; and, uniting in one series the past and the present, to aim at generalizations sufficient to task, to their utmost capability, the limited powers with which man, in his present state of existence, has been endowed.

END OF PART I.

INTRODUCTION TO ZOOLOGY

FOR THE

USE OF SCHOOLS.

PART II.

VERTEBRATE ANIMALS.

——————"Earth in her rich attire,
Consummate, lovely, smiled; air, water, earth,
By fowl, fish, beast, was flown, was swum, was walk'd."
MILTON'S PARADISE LOST.

WE have had our attention directed to the three groups of animals termed "Invertebrate," from the absence of the vertebral * column; and we are now prepared to enter upon the examination of the more highly organized beings which constitute the fourth great division of the animal kingdom. These have a more complex structure and a higher intelligence; many of them by their great strength and vast proportions must excite our amazement; and in this class, after passing many inferior grades, we reach to man himself, "the paragon of animals."

The most obvious character by which the Vertebrate Animals are distinguished from the lower tribes is, as the name denotes, the possession of a skull and back-bone; or rather by their "having the brain and principal trunk of the nervous system included in a bony articulated case, composing the skull and vertebral column." † There are other important

* "*Vertebral*, as consisting of segments of the skeleton, which turn one upon the other, and as being the centre on which the whole body can bend and rotate; from the Latin *verto*, *vertere*, to turn."—*Professor Owen's Lectures on the Vertebrate Animals.*

† Manual of British Vertebrate Animals. By the Rev. Leonard Jenyns, M.A.

though less striking characteristics. Vertebrate Animals possess red blood, a muscular heart, distinct senses, a mouth furnished with two jaws moving vertically, and limbs which, however modified in form, never exceed four in number.

The skeleton of Vertebrate Animals presents considerable variety, not only in its form, but in the material of which it is composed. Bone consists of animal matter, chiefly gelatinous, hardened by a general diffusion of earthy particles. The proportion of the animal and of the earthy parts, or, in other words, the proportion of the organic and inorganic matter, varies in different classes. "Fishes have the least, birds the largest, proportion of earthy matter;" "the mammalia, especialy the active predatory species, have more earth, or harder bones, than reptiles." In each class there are differences in the density of bone among its several members. For example, in the freshwater fishes the bones are lighter, and retain more animal matter, than in those which swim in the denser sea; and in the dolphin, a warm-blooded marine animal, they differ little in this respect from those of the sea fish.*

The Vertebrate Animals are distributed into four classes, namely:—

I. FISHES.
II. REPTILES (*Tortoises, Lizards, Serpents, Frogs.*)
III. BIRDS.
IV. MAMMALIA† (*Man, Bats, Whales, Quadrupeds.*)

Two of these, Fishes and Reptiles, are, with few exceptions, cold-blooded; and the remaining two, Birds and Mammalia, are warm-blooded.

* Professor Owen's Lectures on the Vertebrate Animals, p. 25.

† Most of the animals belonging to this Class, being four-footed, it is not unusual in systematic works of a popular character, to speak of them all (including the bats and whales) as "*Quadrupeds*," instead of using the more scientific term "*Mammalia*."

CLASS I.

PISCES.—FISHES.

"They that go down to the sea in ships, and occupy their business in great waters;
"These men see the works of the Lord, and his wonders in the deep."
PSALMS.

How widely different are the ideas suggested by the word "Fish" to the minds of the angler, the epicure, the fisherman, and the naturalist! The last is here to be our guide; and, according to his definition, fishes are cold-blooded animals, eminently and specially adapted for living as inhabitants of the water. The body is, in most instances, covered with scales; they have fins instead of feet; and respiration is carried on by gills. The young are produced from eggs.

DISTRIBUTION.—Fishes are found in rivers, lakes, and seas, and, according to the laws of geographical distribution, have certain limits within which they range, and beyond which they seldom pass. Some live habitually in temperatures far above that which we would have ventured to suppose. Thus, fishes have been observed in a hot spring at Manilla, which raises the thermometer to 187°, and in another in Barbary, whose usual temperature is 172°;* and Humboldt mentions that, during his researches in tropical America, he found them thrown up alive from the bottom of an exploding volcano, along with water at that time so hot as to raise the thermometer to 210°, or within two degrees of the boiling point. An observation, made under such circumstances, does not, however, furnish any evidence as to the temperature of the water in which such fishes *habitually* lived. When the vital actions are suspended by excess of cold, and the fish congealed in a mass of ice, life does not appear to be permanently extinguished. With the gradual thawing of the ice, all the powers of life return: hence, in the northern parts of Europe, Perch and Eels are conveniently transported from one place to another while in a frozen state. Even the same species seems

* See Notes to Dr. W. F. Edwards' work "On the Influence of Physical Agents on Life."

capable of bearing considerable extremes of heat and cold. The delicate-looking Gold-fish thrives and breeds to excess in water the temperature of which is so high as 80°, and has been known to be frozen into a solid body of ice, and revived by the gradual application of warmth.*

Form.—The great variety of form observable among fishes may be illustrated by reference to some of our most common native species—the Eel, the Plaice, and the Haddock. Some fishes have aspects so strange and grotesque that the names "Fiddle-fish," "red-riband," and "Hammer-head," have been bestowed on them, as indicating their resemblance to some well-known object. There are some, which to a certain extent, can vary the form of their body at pleasure. Thus the Diodon,† or Globe-fish (*Fig.* 179), by swallowing air,

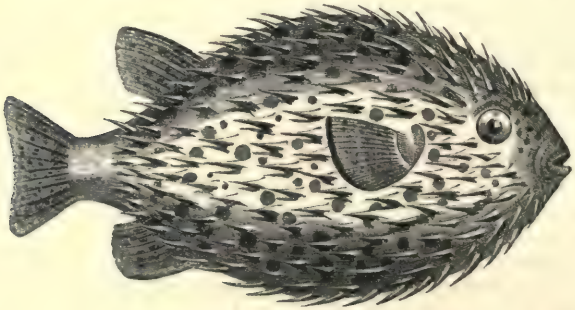


Fig. 179.—Globe-Fish.

can inflate itself like a balloon. The air passes into the first stomach, which occupies the lower surface of the body. This part, becoming the lightest, is that which remains uppermost, and the fish floats on the surface with its usual position reversed. But, while thus floating without effort, it is in the most perfect security from all its usual enemies: for, owing to the distension of the skin, the numerous spines with which it is beset become erect, and present a bristling front on every

* Jesse's Second Series of Gleanings in Natural History.

† This fish belongs to a family which has no true teeth, but in which the gums are covered with a substance resembling ivory. The enamel in each jaw is without any division, so that the fish appears to have but two teeth—whence its name Diodon.

side to all assailants.* Cuvier doubts whether the Diodon, when in this position, is able to swim; but Mr. Darwin's observations show that it can not only move forward in a straight line, but that it can also turn to either side.†

COVERING.—Most fishes are covered with scales, which differ considerably in their shape, and are yet so uniform in each particular kind that they serve as valuable aids in the discrimination of species. Those along the well-marked line observable on both sides of the body are distinguished from the others in shape, and each of them is found to be pierced with a small hole, which is, in fact, the extremity of a tube. Through these orifices a mucus or slime is emitted. This forms a coating to the body, and diminishes the friction of its passage through the water. These apertures are, in general, larger and more numerous about the head than over the other parts, and may be regarded as one of those beautiful provisions of Nature which we are permitted so frequently to observe and to admire. "Whether the fish inhabits the stream or the lake, the current of the water in the one instance, or progression through it on the other, carries this defensive secretion backwards, and spreads it over the whole surface of the body."‡ The scales are sometimes marked with minute lines, possess a varying metallic lustre, and exhibit a diversity of brilliant colours, which render them highly attractive objects.§ The poet is perfectly accurate when he describes fishes, which,

> ——————"Sporting with quick glance,
> Show to the sun their waved coats dropt with gold."—MILTON.

Thus the wide-spreading sea has in its waters tribes of beings fitted for that element, and scarcely, if at all, inferior in richness of colouring, variety of figure, or grace of movement, to those which are the admired denizens of the air.

* M. Edwards' "Elémens," p. 305. Roget's Bridgewater Treatise, p. 433.

† Darwin's Journal, p. 13. "Voyages of the Adventure and Beagle."

‡ Yarrell's History of British Fishes, p. 4.

§ The brilliant metallic colours of the scales of fishes are thus accounted for by Dr. J. L. Drummond:—"The scales of fishes are pellucid; and their brilliant appearance is owing to a thin film which covers the under side of each scale, and is entirely formed of spicula, as is easily proved by scraping off a quantity of scales, and agitating them in water with a stick or other body, so as to detach the films. The water will then be found to contain thousands of moving spicula, which in the sunshine may be discerned

But, although we may convince ourselves of the truth of this remark, by an examination of those on our own shores, we should not limit our view to them, but extend it to those of other seas. There, with new forms we find new vestments. Thus, the Trunk-fish* (*Ostracion, Fig.* 180), and the Pipe-fishes of our own shores (*Fig.* 182), instead of being covered with flexible scales, are clad in a covering of bony plates firmly united together, reminding us of a tessélated pavement; and if we look back to those which in remote eras were the inhabitants of these seas, and whose remains are found imbedded in rocks of marine formation in different parts of these islands, we find numerous tribes whose coats of mail did not consist of bone but of enamel.

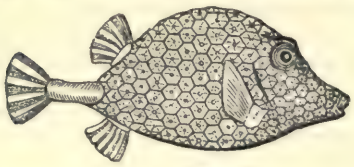


Fig. 180.—Trunk-fish.

Senses.—The sense of feeling can scarcely be exerted in its fullest extent by the bodies of fishes, covered as they are with their scaly integuments. From this remark, however, we should except the long *cirri* or feelers of certain fishes, which are placed about the mouth. "These appendages," says Mr. Yarrell, "are to them delicate organs of touch, by which all the species provided with them are enabled to ascertain, to a certain extent, the qualities of the various substances with which they are brought in contact; and are analogous in function to the beak, with its distribution of nerves, among certain wading and swimming birds which probe for food beyond their sight; and may be considered another instance, among the many beautiful provisions of Nature, by which, in the case of fishes feeding at great depths, where light is deficient, compensation is made for consequent imperfect vision."† As the

with the utmost ease by the naked eye. The scales of the Salmon answer best for the purpose, as they are large and easily detached."—"On certain Appearances Observed in the Dissection of the Eyes of Fishes."—*Trans. Roy. Soc. of Edinburgh.* 1815.

The slender, flat, silvery bodies, here named "spicula," are perfectly opaque, and must therefore be examined under the microscope by *reflected* not by *transmitted* light: when thus seen, their brilliancy is almost too great for the eye to sustain.—*Idem.*

* M. Edwards' "Elémens," p. 303. Roget, p. 432.

† British Fishes, p. 30.

prey of fishes is seized by the mouth, and retained there until swallowed; and as the mouth at the same time admits the stream of water to the gills, but little mastication can possibly take place; there is, consequently, but little exercise of the sense of taste. Its existence is, however, indicated in some species both by the structure of the skin which covers the palate, and by the supply of nerves.

The sense of smell would appear to be enjoyed in great perfection, not only from the development of the olfactory nerves, but also from observations respecting habits. Mr. Jesse states of fish which he kept in a pond suitable for the purpose, that they preferred paste and worms that had been prepared by particular perfumes.

The existence of the sense of hearing in fishes has been questioned ere now, because there is no external organ analogous to an ear. But the pleasing writer just quoted informs us, that he has seen fishes suddenly move at the report of a gun, though it was impossible for them to see the flash;* and we know that the Chinese summon their Gold-fish to their food by the sound of a whistle. The researches of the anatomist would, however, be sufficient of themselves to remove such a doubt, if it were ever seriously entertained. He reveals to us the existence of a special apparatus for the purpose, presenting great diversity in its arrangement; and we learn that in cases such as those just mentioned, the sonorous vibrations of the water were communicated to the organ of hearing through the medium of the solid parts of the body. In many species there is a communication between the ear and the air-bladder; and it has hence been inferred that the air-bladder, among other uses, serves to increase the intensity of the undulations communicated through water to the body of the fish.† With the parts of the auditory apparatus, called the *otolites*, or ear-bones, every one is familiar.

The sense of sight exists in great perfection; but the lenses of the eye are modified to suit the denser medium through which the rays of light must pass. In general, the eye is much rounded, and the pupil is large, so as to allow the greatest possible quantity of light to enter. But while such careful arrangements are made for the sense of vision, in all cases where that power can be exerted, the economy of nature,

* Gleanings in Natural History, p. 74.

† Müller, quoted in Owen's Lectures, p. 211.

which gives nothing in vain, has withheld the gift from those species whose dwelling-place is such as to preclude the possibility of its exercise. An instance of this is supplied to us from Kentucky, where there is a cavern, known because of its great dimensions by the name of the Mammoth Cave.* It is said to extend to a distance of upwards of twenty miles, and has obviously been excavated by the long-continued action of a subterranean river. There is an expanse of this river, about four miles from the entrance, forming a subterranean lake. Here the sense of sight would be useless; and it is found, accordingly, that the fishes which inhabit those gloomy waters are without eyes;† or, to speak more correctly, the visual organs exist only in a rudimentary condition. The capture of these fishes is, nevertheless, difficult, because of the great acuteness of their sense of hearing.

The eyes of fishes exhibit striking peculiarities. They are without eyelids, properly so called;‡ and as the eye is at all times washed by the surrounding water, that gland which supplies moisture to the eye of the higher vertebrate animals is not required, and therefore does not exist. The colours of the eye are of great beauty, varying through various shades of black, blue, red, yellow, and richest orange.

Locomotion.—We now turn to the consideration of the various structural peculiarities, by means of which fishes are enabled to move through the waters with the same, or even greater ease, than the Hawk and the Swallow wing their course through the air. The first bears reference to the weight of the body of the fish, compared with that of the medium in which it lives. This specific gravity, to use the proper term, is nearly the same in both; or, in other words, the weight of the body of the fish is nearly the same as that of an equal

* There is a popular description of the Mammoth Cave in Chambers' Edinburgh Journal, 1837, vol. vi.—and again, in 1843, vol. xii.

† W. Thomson's Notice of the Blind-fish, Cray-fish, and insects from the Mammoth Cave, Kentucky. Annals of Natural History, vol. xiii. p. 112. some of these blind-fish are preserved in the Belfast Museum. Not only the fish, but the crustacea and insects, are specifically distinct from those found elsewhere; and in all of them the eyes are apparently wanting, or greatly diminished in size. The "Blind-fish" (*Amblyopsis spelæus*) is described in Silliman's American Journal of Science, July, 1843, p. 94; and in Annals Nat. Hist., Oct. 1843.

‡ The fold of the skin observed on the eyes of the Dog-fish and other Sharks, is not generally regarded as a true eyelid.

bulk of water. If the specific gravity should be increased the fish would necessarily descend, without any muscular exertion; or, if diminished, the fish would become lighter than the water, and would, therefore, rise to the surface. A beautiful arrangement, by which the fish can thus rise or sink at pleasure, and without exertion, is exhibited by a singular and effectual piece of mechanism, provided apparently for this purpose. It is a membranous bag, placed at the lower side of the spinal column, and known as the "swim-bladder" or "air-bladder." In the Cod-fish it is the part which is called the "sound." It differs much in form, and sometimes consists of two or more membraneous bags, with small connecting apertures, or with the divisions quite distinct, or with prolongations from the sides or ends.* But whatever be the form, the principal use seems to be the same—namely, that of enabling the fish to regulate the specific gravity of its body.

Professor Owen regards it as the representative in fishes of the true lung of the air-breathing vertebrate animals. It is brought as we have seen (p. 201), into connexion with the chamber or labyrinth of the organ of hearing; and in a few fishes it is subservient to the production of sounds, which are caused by the air passing from the air-bladder, by means of an air-duct, into the gullet (*œsophagus*). It appears also to act in some cases, as a safety-valve against high-pressure, when the fish sinks to great depths, and to a limited extent as a protection against the too sudden expansion of the gas, when the fish rises to the surface.†

When we begin to examine to what extent this mechanism prevails among fishes, we find it is by no means universal. It is not observed in the Plaice, the Turbot, the Sole, and other flat fishes; and as these different species live near the bottom of the water, we are at first inclined to say it is not given to them for that reason, but that it is given to those which are in the habit of rising and sinking. A little further examination, however, shows that we are mistaken. Eels, which live near the ground, have the swimming-bladder well developed: while the Red Mullet, which has no swimming-

* Lectures, p. 227.

† The gas in the air-bladder is found to consist of *nitrogen* and *oxygen*, the constituents of atmospheric air in varying proportions. No *hydrogen* has ever been detected. Owen's Lectures, p. 277.

bladder, seems, in its habits, to be similar to fishes which are thus provided. Nay, of two species of Mackerel found on the British coasts, both of which swim near the surface, and with apparently the same ease and swiftness, one has a swim-bladder and the other has not.*

The external organs of motion act in a manner more easily understood. They consist of the tail and fins. We use the word "tail" as expressing not only the lower extremity of the body, but also the fin by which the body is terminated, appropriately called the "caudal fin" (Latin, *cauda*, a tail). This is the most efficient organ in progression. It acts upon the water somewhat like the oar of the boatman, when he propels his little craft by that alternate movement of the oar which is called "sculling." The tail—placed vertically in fishes, but horizontally in whales—is a very powerful instrument of motion. To its movement a great part of the muscular power of the fish can be applied; and the great flexibility of the skeleton largely adds to the effect. The fins on the upper and lower portions of the body bear their part in the exertion, or unite with those nearer the head in retarding, stopping, or changing the direction of the movement. The annexed figure of the Perch (*Fig.* 181) exhibits the fins, and also the spiny processes by which they are supported.



Fig. 181.—Skeleton of the Perch.

The fins upon the back of the fish are naturally termed the "dorsal" fins (*dorsum*, the back), and if there be more than

* Yarrell's British Fishes, vol. i. p. 39.

one, that nearest the head is distinguished as "the first dorsal." Those near the gills, on what might be called the shoulders of the fish, are the "pectoral,"* and the pair nearest to them, but on the lower surface of the body, are of course the "ventral."† Thus the fins, in all cases, are named from the part of the body to which they are attached.

In the summer of 1846 we had an opportunity of observing the capability of the fins and tail in enabling a fish to achieve a movement of a very unusual kind. We had taken in a towing-net one of the Pipe-fishes (*Syngnathus acus, Fig.* 182), which had been swimming near the surface, and had placed it in a basin of sea-water.‡ One of the long-bodied crustacea



Fig. 182.—PIPE-FISH.

which are abundant during fine weather, and had been captured at the same time, was placed in the same vessel. It was a species of *Gammarus*,§ and about an inch in length. The Gammarus would seem to have got tired of swimming, and,

* Latin, *pectoralis*, of or belonging to the chest.

† *Venter, ventris*, the belly. The fin or fins between the tail and the vent are called the "anal."

‡ Among the pleasant circumstances connected with the preparation of this little book, I reckon the kindness with which my efforts have been encouraged and assisted. Among those to whom my obligations are thus due, I must make especial mention of Mr. Yarrell and Mr. Van Voorst, by whose liberality I have been permitted to copy some of the beautiful illustrations of the "British Fishes." They are the figures numbered 182, 183, 191, 194, 195, 204.—R. P.

§ Its appearance will be best understood by the annexed figure of *Gammarus locusta*.



for a resting-place, it fixed itself on the back of the Pipe-fish, close to the tail. The fish had not been a consenting party to this arrangement, and soon evinced its dissatisfaction, by lashing the tail with great violence on each side, to dislodge the intruder. He, however, kept his hold; and so soon as the fish ceased for a few seconds, he crept a little farther up on the back, as if aware that the velocity of movement was less near the centre of the circle. The fish lashed the water again with great violence, but without any good result; and so soon as it stopped, the Gammarus crept up a little nearer to the head. The Gammarus seemed to be the marine prototype of the Old Man of the Mountain, whose pertinacity in retaining his place on the back of Sinbad the Sailor is a portion of that lore of our boyhood that is never afterwards forgotten. The Pipe-fish then changed its tactics. Instead of lashing with its tail, it gave to its whole body the kind of movement it might have had if fixed on a Lilliputian spit, and in the act of being roasted. The body was made to revolve round and round on its longitudinal axis; but the Gammarus still held on, and, at each interval of rest, made a few steps farther in advance. This was more than once repeated, until, pitying the poor Pipe-fish, we removed the cause of its annoyance to another vessel.

In the Flying-fishes (example *Exocœtus volitans*, *Fig.* 183),

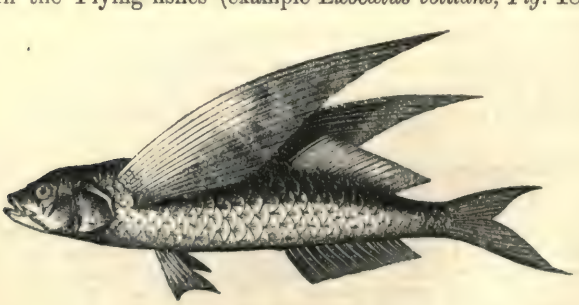


Fig. 183.—Flying-fish.

more than one species of which have been taken off the British coasts, the pectoral fins are extremely large, and remind us of wings. But in reality the fins never act as wings; nor can these fish, with correctness, be said to *fly*. They have the power of springing out of the water with such force, that

Capt. Hall has seen them pass over a space of 200 yards; but they cannot alter the direction of their course, and the expanded fins, when in the air, serve only to make the descent more gradual.*

Respiration.—The heart of fishes is composed of two cavities only. It receives the blood which has circulated through the system, and propels it to the gills. These are the great organs for respiration, and in the greater number of fishes are arranged in the form of arches on each side of the hinder part of the head. The water is taken in at the mouth, and passes out between these arches, where the venous blood in the gills is purified by the air diffused through the water. The delicate membrane by which the minute ramifications of the blood-vessels are supported, forms no obstacle to the free action of the water on the impure or carbonated blood. The details connected with the circulation will be more easily understood by an examination of the annexed figure (184) than by any formal description. The true cause of death in a fish kept out of water is an interesting question, which appears to have been satisfactorily answered by M. Fleurens, a French physiologist. Though the gill-cover be raised and shut alternately, the gills themselves are not separated. Their fine filaments rapidly dry and cohere together. The blood can no longer circulate through them, and hence it is not affected by the vivifying influence of the oxygen of the air. "The situation of the fish is similar to that of an air-breathing animal enclosed in a vacuum, and death by suffocation is the consequence."† The gills vary considerably in form and arrangement. Some are convoluted, some are in little tufts, some are enclosed in cavities, with circular orifices, and others furnished with gill-covers composed of distinct bones, to which certain fixed names are appropriated.

Food.—Some fishes live upon marine vegetables. The species of one genus (*Scarus*) are known to browse upon the living polypes which built up the coral reefs; and as the polypes retreat, when touched, into the star-shaped cavities of their support, these fishes are furnished with a dental apparatus

* Fragments of Voyages and Travels. Second series, vol. 1, p. 220. A more recent writer asserts that the fins *are* used as wings; *vide* Note in Edinburgh Phil. New Journal, April, 1847, p. 384, from Gardner's Travels in Brazil.

† Yarrell, vol. i. p. 67. Owen, p. 60.

sufficiently powerful to reduce it to a pulp. To some the dead animal body seems to be not less acceptable than the

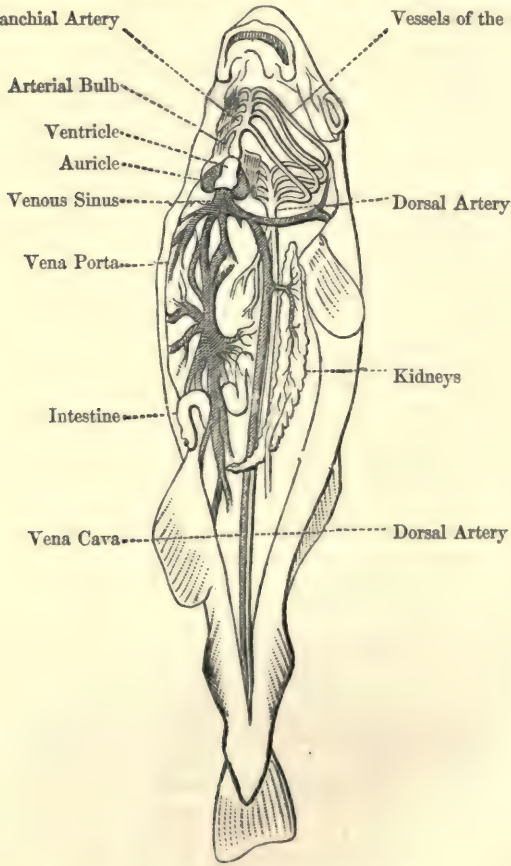


Fig. 184.—Circulating Apparatus of Fish.

living. Star-fishes, crustacea, and such mollusca as are not too bulky or too well defended, constitute a large portion of the food of many fishes; and to this must be added the young

and weaker animals of their own class. One of our justly popular poets has said:—

> "Even tiger fell, and sullen bear,
> Their likeness and their lineage spare;
> Man only mars kind Nature's plan,
> And turns the fierce pursuit on man."
>
> ROKEBY, canto iii. stanza 1.

Such a remark is altogether inapplicable to the voracious tribes of which we at present treat, and we would refer to it here only to show how much more completely "kind Nature's plan" is carried out by the present arrangement. As it is, "the multitudinous seas" are peopled with their finny tribes; and we cannot doubt that the exercise of their various powers in the pursuit of prey, the escape from danger, and all else that is essential to their well-being, is fraught with happiness. They have no apprehension of death; and when it does come by the jaws of a more powerful assailant, the pain is brief and transient. The pleasure has extended throughout the duration of life; the final pang endures but for a moment. Great, therefore, in the aggregate, is the amount of happiness secured under these wise and bountiful dispensations of Providence. Did fishes not constitute the food of fishes, how few comparatively could exist! The naturalist consequently beholds, in all the havoc and destruction of life by carnivorous animals, a merciful dispensation, and is prepared to give his assent to the reflections of the poet:—

> "Harsh seems the ordinance, that life by life
> Should be sustained; and yet when all must die,
> And be like water spilt upon the ground,
> Which none can gather up, the speediest fate,
> Though violent and terrible, is best.
>
> "'Twas wisdom, mercy, goodness, that ordained
> Life in such infinite profusion.—Death
> So sure, so prompt, so multiform."
>
> MONTGOMERY'S "PELICAN ISLAND."

To those who have never considered the omnivorous appetite of fishes, the examination of the stomach of a few of those which are most commonly used as food, will furnish very sufficient evidence of their habits. Perhaps the fact cannot be better exemplified than by quoting a passage from a

lecture delivered by Dr. Houston of Dublin, before the Royal Zoological Society of that city:—

"This preparation (for the fidelity of which I can vouch, as it belongs to the Museum of the Royal College of Surgeons, and which may be taken as a fair average specimen of a fish's breakfast party, captured at an early hour of the morning) will serve as an illustration of the voraciousness of their habits. Here is the skeleton of a Frog-fish, two-and-a-half feet in length, in the stomach of which is the skeleton of a Cod-fish, two feet long; in whose stomach again are contained the skeletons of two Whitings of the ordinary size; in the stomach of each Whiting there lay numerous half-digested little fishes, which were too small and broken down to admit of preservation. The Frog-fish, with all these contents, was taken last summer by the fishermen, and offered for sale in the market, as an article of food, without any reference at all to the size of its stomach, which to them is an every-day appearance."*

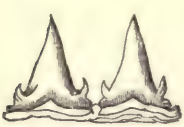
Teeth.—From considering the food of fishes, we naturally turn to the means by which that food is taken. Here we perceive at once that we have got into a new country, and that the tribes by which it is peopled secure their prey by modes very different from those which we have hitherto witnessed. In some of the lower tribes, the action of parts adjoining to the mouth caused currents in the water, and thus supplied the animal with food. The suckers of the Star-fish and the Sea-urchin held fast the prey on which the creatures fed. The lower jaws of the carnivorous beetles maintained their hold while the upper jaws performed their office of laceration. The larger crustacea had feet which did the same duty. The Cuttle-fish, by means of its suckers, rendered escape impossible, and held its struggling captive firm as in a vice, while its parrot-like beak tore it to pieces. But fishes are destitute of all these appliances. The teeth must seize the prey, and must retain the struggling and slippery victim until swallowed; and admirably are they fitted for the performance of their appointed functions; so much so, indeed, that the anatomist finds difficulty in obtaining the command of language sufficiently varied to portray the singular diversity and beauty which they exhibit. "The teeth of fishes, in fact, in whatever relation they are considered—whether in regard to number, form, substance

* Saunders's News-Letter.

structure, situation, or mode of attachment—offer more various and striking modifications than do those of any other class of animals."*

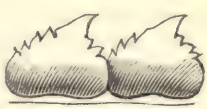
The teeth of some fishes, as the true Red Mullet, are so fine and close set, that they may be felt rather than seen, and have been compared to plush or velvet. Others, a little coarser, resemble the hairs of a fine brush; when stronger, they are like stiff bristles; and some are bent like hooks and barbed. Some of those in the Pike are shaped like the canine teeth of carnivorous quadrupeds; and some molar teeth are elliptical, oblong, square, or triangular. To such teeth, those of the Sharks (*Figs.* 185, 186) shaped obviously for piercing, cutting, and holding, offer an interesting contrast.

Fig. 185.



TEETH OF SHARK (*Notidanus.*)

Fig. 186.



TEETH OF SHARK (*Odontaspis.*)

Nor is the variety in point of numbers less than that of form. The Lancelet, the Sturgeon, and the Pipe-fish are without teeth. The Wolf-fish, on the contrary, has a mouth so paved with teeth that it breaks shells to pieces, and lives on the contained animals, separating the one from the other so effectually, that the food, without further preparation, is ready to be consigned to the stomach. "In all fishes the teeth are shed and renewed, not once only, as in mammalia, but frequently, during the whole course of their lives."†

At the back part of the mouth, the upper end of the gullet (*œsophagus*) is expanded and forms a cavity known as the pharynx. In many species of fish this is furnished with teeth, and it becomes an interesting question—what can be their use in such a situation? A recently-swallowed fish, taken from the stomach of a Pike, may show marks of the

* Owen's Odontography, page 1. It is from this splendid work and the more recent Lectures of the same eminent author, that our information respecting the teeth is derived.

† Yarrell.

large canine teeth, but has obviously not undergone any further subdivision. It has now been ascertained that the coarser portions of the food, from time to time, return into the œsophagus, and are brought within the sphere of the teeth with which the pharynx is furnished; and, after being there carded and comminuted, are again swallowed. In the Carp, the Tench, the Eel, the Pike, and many other fishes, we have thus an action analogous to that of rumination in the cattle of our pastures.*

Reproduction.—A few fishes are brought forth alive—as, for example, the young of the Viviparous Blenny; but such instances are rare; and, as a general rule, it may be stated that fishes are produced from eggs deposited by the female, and fertilized by the male. The lobes containing the ova are those to which we are accustomed to give the name of "pea" or "roe," and the corresponding but softer lobes in the male fish, are those which are equally well known as the "milt." It has been found by experiment, that when the spawn of both sexes has been taken from dead fishes and mixed together, the ova, placed under water and kept in a proper situation, will produce young. This fact may serve, as Mr. Yarrell remarks, to explain how it is that ponds in the East Indies, which have become perfectly dry and the mud hard, have been found, after the rainy season, with fishes in them, although there did not exist any apparent means by which fish could be admitted. The impregnated ova of the fish of one rainy season continued unhatched in the mud while the pond is dried up; but then vitality remains unimpaired and the young are produced under the influence of circumstances favourable to their development when the rainy season has again arrived. We can thus explain, by the operation of natural causes, what was regarded as a puzzling phenomenon, for the solution of which many hypotheses have been framed, alike destitute of any solid foundation.

Distribution.—The researches of naturalists have shown that certain fishes are not merely limited in their range, according to the laws of geographical distribution, but also have depths to which they are in a great degree restricted. Hence, some are most usually found at or near the surface; some are ground-feeders, and are taken at consider-

* Owen.

able depths; and some occupy various intermediate stations. When we reflect on the great amount of animal life which the ocean in its several zones of depth must thus support, and consider that by far the greater number of young fishes never attain maturity, but form the appointed food of their more powerful neighbours, it is obvious that the young fry must be produced in numbers sufficient to bear this ceaseless destruction, and yet to have among them a sufficient number of individuals which escape these perils to attain a certain degree of maturity, and, by the deposition of their ova, prevent the species from perishing. And accordingly we find here, as in every other department of nature, that HE who framed the mighty scale of created beings, has so arranged the living mechanism, that the continual production is equal to the continual waste. The number of ova which some of our native fishes produce is so very astonishing that it would be regarded with doubt, except on the most unimpeachable testimony. So many as 280,000 have been taken from a Perch of only half a pound weight. Mr. W. Thompson found 101,935 ova in a Lump-sucker (*Cyclopterus lumpus*) of fifteen inches in length,* and the Cod-fish is said to produce several millions.

In general, with the deposition of the spawn the care of the parents for their future offspring terminates; but this is not invariably the case. The statement of Aristotle, that there was a fish (*Phycis*) in the Mediterranean which makes a nest and deposits its spawn therein, has been confirmed; and Olivi adds, that the male guards the female during the act of oviposition, and the young fry during their development. Dr. Hancock has observed similar habits in some Demerara fishes called "Hassars." "Both male and female remain by the side of the nest till the spawn is hatched, with as much solicitude as a hen guards her eggs; and they courageously attack any assailant. Hence the negroes frequently take them by putting their hands into the water close to the nest; on agitating which, the male *Hassar* springs furiously at them, and is thus captured."†

But we need not go so far as the West Indies to find ex-

* Annals Nat. Hist., vol. iii. p. 44.

† Quoted in Owen's Lectures. A nest of the *Hassar*, with the spawn and the parent fish, is in the Museum of the Royal College of Surgeons, London.

amples of fishes constructing nests, and evincing a remarkable degree of care and anxiety for their young. The observations of Mr. Couch prove, that, on our own shores, "nests are built, in which the ova are deposited, and over which the adult fish will watch till the young make their escape." On one occasion this gentleman visited daily for three weeks a nest of the Fifteen-spined Stickle-back (*Gasterosteus spinachia*), formed of sea-weed and the common coralline, and invariably found it guarded; nor would the old fish quit its post so long as he remained.*

MEANS OF ESCAPE, DEFENCE, AND ATTACK.—In some tribes safety is to some extent secured by the colour of the skin being inconspicuous. It was an old belief, when the real fructification of the ferns was unknown, that the possession of the seed gave supernatural powers of concealment; and hence Shakespeare says:—"We have got the fern-seed; we walk invisible." Without possessing the fern-seed, there are certain fishes that enjoy, to some extent, the gift which it was supposed to bestow; and such fishes are living in great abundance on our own shores. We allude to some of the most common flat-fishes. Let any one try to see them as they lie upon the bottom, and he will be convinced it is not an easy matter. When in motion they are of course detected, and occasionally the white side of the body shows for an instant as they glide along; but as soon as they stop, and by the action of the fins have settled down into the sand, they are so similar in colour to the surface on which they rest that they escape detection, unless the eye has watched the movement. All parts of the beach, are not, however, of the same material, and therefore are not of the same colour; but, whatever it may be, the upper surface of the fish exhibits a correspondence which is very remarkable. We have seen it of a uniform dark tint, similar to that of the muddy bottom on which the fish had been found; while on others it was of a mottled or pepper-and-salt colour, like the gravel of the little bay in which it had been captured.

The Flying-fish springing into the air when pursued by the Bonito, is an example of a different mode by which danger is avoided. Others, however, do not content themselves with

* Notes on the Nidification of Fishes, by R. Q. Couch, Esq., published in "The Zoologist," vol. ii. p. 795. 1844.

concealment or escape, but wield with energy their peculiar weapons of defence. The Skate has a tail armed with sharp spines; the point of the nose and the base of the tail are bent towards each other, and the tail, when lashed about in all directions, is capable of inflicting severe wounds. The Weaver (*Trachinus draco*) is furnished with spines on the gill-cover and on the first dorsal fin, which have the power of inflicting severe wounds, and even of imparting a venomous secretion. This power, which has been questioned by modern writers, was well known to the ancients, though they attributed venomous powers to some species which are certainly harmless.*

> ——————"Cruel spines
> Defend some fishes, as the Goby, fond
> Of sands and rocks, the Scorpion, Swallows fleet,
> Dragons and Dog-fish, from their prickly mail
> Well named the spinous. These in punctures sharp,
> A fatal poison from their spines inject."—OPPIAN.

Pennant says that he has seen the lesser Weaver direct its blows with as much judgment as a fighting cock.

The Picked or Spined Dog-fish (*Acanthias vulgaris*) is distinguished from all other Sharks by a single spine placed in front of each of its two dorsal fins. "This fish," says Mr. Yarrell, "bends itself into the form of a bow, for the purpose of using its spines, and by a sudden motion causes them to spring asunder in opposite directions; and so accurately is this intention effected, that if a finger be placed on its head, it will strike it without piercing its own skin."

These spines, which are three-sided, and very sharp, are perfectly developed in the young fish prior to birth, and Mr. Ball has made known to us a beautiful provision by which they are prevented at that time from lacerating the mother. Each point is covered with a small knob of cartilage, fastened by straps of the same material, one of which passes down each of the sides of the spine, so as to be easily detached at birth, thus allowing the little animal (like the goddess of classic fable) to commence life effectively armed.†

* Dr. G. J. Allman, Annals Nat. Hist., vol. vi. p. 161. He had suffered acute pain from a wound inflicted by the spine attached to the gill-cover of the Weaver.

† Proceedings of the Royal Irish Academy, 27th April, 1846. Mr. Ball exhibited at the same time two perfectly-formed young, which he had taken from the mother on the 30th of the preceding November.

The common Stickle-back * (*Gasterosteus*, *Fig.* 187) of our

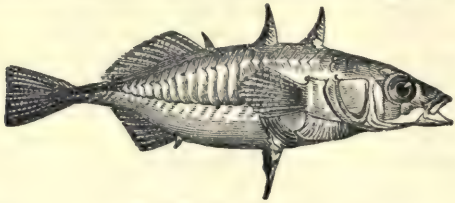


Fig. 187.—Stickle-back.



Fig. 188.—Saw-fish.

streams seems to be provided with a weapon, which to its opponents would prove no less formidable. At the lower surface of the body, it has a stiff, sharp spine, which can be erected at pleasure, and so firmly that it may be said, in military phrase, to "fix bayonets."† The Stickle-back is an irritable and pugnacious little fellow; and with this bayonet of his has been seen to rip up the belly of an unfortunate antagonist, so that he sank to the bottom and died of his wound.

An active species of Shark has the teeth within its mouth small and obtuse, and wholly inadequate to destroy the prey on which it subsists; but this deficiency is compensated by a singular and formidable weapon, with strong lateral projections, with which the front of the head is provided. Its saw-like edge has gained for its owner the appropriate name of Saw-fish (*Pristis*, *Fig.* 188).

The Sword-fish (*Xiphias gladius*) has occasionally been taken upon the British coasts, and is furnished with a weapon, more formidable than perhaps any other species. Daniel, in his "Rural Sports," states that a man while bathing in the Severn, was struck by, and actually received his death-wound from a Sword-fish. The elongated upper jaw (*Fig.* 189) forms the sword, which is fre-

* Called *Sprittle-bag*, or *sprickly-bag*, in the North of Ireland—*Pinkeen* in the South.

† Drummond's Letters to a Young Naturalist.

quently found three or four feet in length. The fish occasionally attains a length of more than twelve feet, and a weight of more than four hundred pounds. It is said to entertain great hostility to the whale; and some of them will join in stabbing it below, while the Fox-sharks will fling themselves several yards into the air, and descend upon the back of their unhappy victim. It is a commonly-received notion, that it is in consequence of mistaking the hull of a ship at sea for a whale that the Sword-fish occasionally thrusts his sword-like beak into the vessel.*

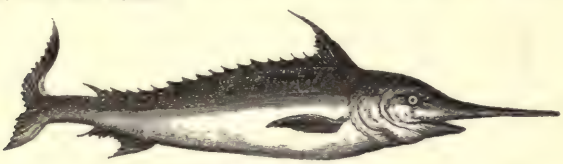


Fig. 189.—Sword-fish.

The force with which this is done must be very considerable: many museums contain planks thus pierced either by the Sword-fish or others nearly allied to it. A portion of its sword, about nine inches in length and two inches diameter, was sent to the Belfast Museum,† taken from the *Euphemia*, a vessel which had become leaky on her passage to Brazil. It had been driven not only through the copper sheathing, but also through nine inches of the solid timbers. Other instances are recorded of vessels having suddenly sprung a leak, and being with difficulty got into port, the Sword-fish having been the origin of the calamity.

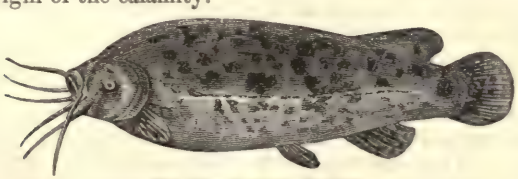


Fig. 190.—Electric Silurus.

But a still more remarkable mode of defence is exercised by some species of fish, in the power they possess of giving a severe electric shock. One of these is the Electric *Silurus* or *Malepterurus* of the Nile (*Fig.* 190), a fish to which the Arabs

* Yarrell, p. 145.

† Thompson, in Annals of Natural History, vol. xiii. p. 235.

give a name signifying *thunder*.* Another is the Torpedo or Electric Ray of our own shores (*Fig.* 191); and a third is the *Gymnotus* or Electric Eel of the South American rivers, whose shock is sufficiently powerful to stun and even destroy horses. Humboldt gives a most graphic picture of the scene attending their capture; the livid yellow Eels swimming near the surface and pursuing their enemies, the groups of Indians surrounding the pond, and the horses with their manes erect and eyeballs wild with pain and fright, striving to escape from the electric storm which they had roused, and driven back by the shouts and long whips of the excited Indians.



Fig. 191.—TORPEDO.

VITALITY.—There are some fishes which die almost immediately when taken out of the water, and others which exhibit symptoms of life after a lapse of several hours. In reference to this subject Mr. Yarrell remarks, "that those fish that swim near the surface of the water have a high standard of respiration, a low degree of muscular irritability, great necessity for oxygen, die soon—almost immediately—when taken out of the water, and have flesh prone to rapid decomposition. On the contrary, those fish that live near the bottom of the water have a low standard of respiration, a high degree of muscular irritability, and less necessity for oxygen; they sustain life long after they are taken out of the water, and their flesh remains good for several days."† The phenomena connected with this law are highly interesting, and excite the attention of the most incurious. Mackerel are so perishable that they are permitted to be cried through London for sale upon the Sunday. Herrings die so instantaneously on their removal from the water, that the saying "dead as a herring," has become proverbial. Perch, on the contrary, live for some hours:—"They are constantly exhibited in the markets of Catholic countries, and, if not sold, are taken back to the ponds from which they were removed in the morning, to be reproduced another day."‡ The Anglesey Morris, a small fish of rare occurrence, has been known to survive after being

* Milne Edwards' "Elémens," p. 281.
† Yarrell, vol. i. p. 8.
‡ Idem, vol. i. p. 22.

wrapped in brown paper, and carried for three hours in a person's pocket.* The Carp is so exceedingly tenacious of life, that it is a common practice in Holland to keep it alive for three weeks or a month, placed in wet moss, and in a net kept in a cool place. A little water is occasionally thrown over the net, and the fish are fed with bread steeped in milk.

ERRORS AND TRADITIONS.—To those who now enter on the study of fishes, with access to the stores of knowledge accumulated by earlier labourers, and having for their guidance the light reflected from other departments of science, the ideas with which some species of fish have been associated cannot but seem strange, incongruous, and unreasonable. But this assumption of superiority is one that a wider range of study assuredly dispels; and it teaches us, at the same time, to hold our own views with humility, seeing how great were the errors of inquirers who were certainly not less able nor less intelligent. The subject is one to which we can only advert, yet it cannot but prove instructive.

The Mackerel Midge, one of the most diminutive of our native fishes (*Motella glauca*), is only about an inch and a quarter in length. "This seems," says Mr. Couch, "to be one of the species spoken of by the older naturalists under the name of *apua*, and which, from their minute size, and the multitudes in which they sometimes appeared, they judged to be produced by spontaneous generation from the froth of the sea, or the putrefaction of marine substances."† The notions with respect to the origin of Eels were not less fanciful. Aristotle believed that they sprang from mud; Pliny, from fragments which were separated from their bodies by rubbing against rocks; others supposed that they proceeded from the carcases of animals; Helmont believed that they came from May-dew, and might be obtained from the following process:—"Cut up two tufts covered with May-dew, and lay one upon the other, the grassy sides inwards, and thus expose them to the heat of the sun; in a few hours there will spring from them an infinite quantity of Eels." Horse-hair, from the tail of a stallion, when deposited in water, was formerly believed to be a never-failing source of a supply of young Eels.‡ The ear bones of the Maigre (*Sciæna aquila*), a fish which attains the length of five or six

* Loudon's Mag. Nat. Hist., vol. vi. p. 330.
† Vide Yarrell, vol. ii. p. 193.
‡ Idem, vol. ii. p. 289.

feet, and has been occasionally taken on the British shores, were supposed to possess medicinal virtues. "According to Belon, they were called cholic-stones, and were worn on the neck, mounted in gold, to secure the possessor against this painful malady: to be quite effectual, it was pretended that the wearer must have received them as a gift—if they had been purchased, they had neither their preventive nor curative power.

The Opah, or King-fish (*Lampris guttatus*), a beautiful species of rare occurrence in the British seas, is by the Chinese termed Tai, and is esteemed as the peculiar emblem of happiness, because it is sacred to Jebis or Neptune. The John Dory (*Zeus faber*, *Fig.* 191*) belongs to the same family,

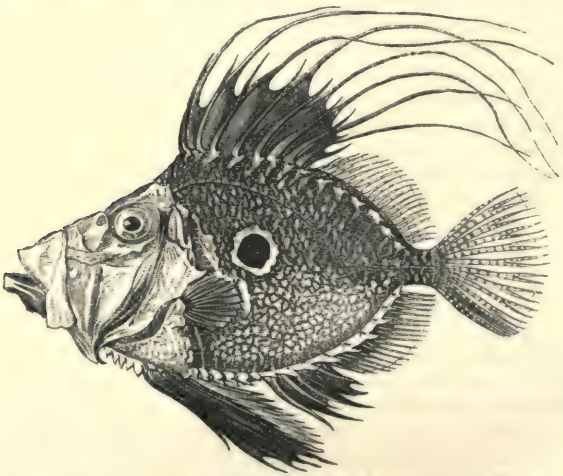


Fig. 191*.—John Dory.

and contends with the Haddock (*Morrhua œglefinus*) for the honour of bearing the marks of St. Peter's fingers—each being supposed to have been the fish out of whose mouth the Apostle took the tribute money, leaving on its sides, in proof of the identity, the marks of his finger and thumb.

In many of the ports of the Mediterranean, the Dory is hence called "St. Peter's Fish."* The fishermen of the Adriatic term it *il Janitore*, "the gatekeeper," a word which

* Cuvier et Valenciennes. Histoire Naturelle des Poissons, vol. x. p. 6.

may have given origin to the English name; or it may have been derived from the French *dorée* or *jaune dorée*, having reference to its peculiar golden colour.

We might greatly enlarge these notices of traditionary lore, as applicable to fishes, but shall merely mention one other example. The Remora (*Echeneis remora*, *Fig.* 192) is re-



Fig. 192.—Remora.

markable for an adhesive or sucking disc, which covers the upper part of the head, and enables it to adhere to the body of another fish, or to the bottom of a vessel. But so great were its fabulous powers, that it was said to be able suddenly to arrest a vessel, even in her most rapid course.

Classification.—To Cuvier we are indebted for that classification of fishes which is most generally adopted. It is founded upon the nature of the skeleton, and on the structure and position of the fins.

The following table exhibits Cuvier's arrangement:—

OSSEOUS FISHES,

OR THOSE WITH THE SKELETON OF BONE.

I. Acanthopterygii, or fishes with spiny rays in the fins. Examples—Perch, Gurnard. This group is not subdivided except into families, genera, and species.

Malacopterygii; or, fishes with flexible fin-rays. This group is divided into the three following orders:—

II. Malacopterygii Abdominales, with the ventral fins beneath the abdomen. Examples—Pike, Salmon, Herring.

III. Mal. Sub-brachiales, ventral fins beneath the pectoral. Examples—Cod, Whiting, Ling.

IV. Mal. Apodes, ventral fins absent. Examples—Eel, Conger Eel.

V. Lophobranchii, the gills arranged in tufts. Example—Pipe-fish.

VI. Plectognathi, jaws as if soldered together. Examples—Globe-fish, Trunk-fish.

CARTILAGINOUS,

OR THOSE WITH THE SKELETON OF CARTILAGE.

VII. Sturiones.—Sturgeons.—Branchiæ pectinated (Comb-shaped), free with one large aperture.

VIII. Plagiostomi.—Sharks and Rays.—Branchiæ pectinated, fixed; gill apertures distinct and transverse.

IX. Cyclostomi.—Lampreys.—Branchiæ purse-shaped, fixed; gill apertures distinct and circular.

In some fishes, as the Skate and the Shark, the skeleton is cartilaginous, or composed of gristle, being so far analogous to the skeleton of the young of the mammalia before the earthy particles which convert the cartilage into bone have been deposited. In others, as the Perch, the Trout, and the Cod, the skeleton is formed of bone. This points out an obvious division of fishes into two primary groups—the cartilaginous and the bony. The latter admit with facility of further division. If we examine the Perch and the Trout, we find the bones of the same material, and the gills formed after the same model. The back in each is surmounted by two fins, but the resemblance ceases when we come to examine the structure of these organs. In the Perch, the first of these dorsal fins, or that which is next to the head, is composed of stiff spines united by a membrane, as shown in the annexed figure (*Fig.* 193), or in that of the entire fish (*Fig.* 181); while in the Trout the corresponding fin is formed of soft flexible rays, dividing into branches. A difference of the same kind is observable in the anterior or front portion of some of the other fins: the tail fin consists, in both cases, of the most flexible rays. This difference in the dorsal fin (Latin, *dorsum*, the back) may seem a very trivial matter; but it enables the naturalist to divide the osseous or bony fishes into two orders —those with the fins partly of hard or spiny rays (*Acanthopterygii*), and those with the fins entirely of soft rays (*Malacopterygii*).* These orders are again subdivided, according to the presence or absence of certain fins—the difference in their relative positions—the variety in the structure of the gills and gill-covers, and other details of secondary importance. By these characteristic distinctions the ichthyologist, or in other words the naturalist who makes fishes his peculiar study, arranges them in groups, distinguished as orders, families, and genera.

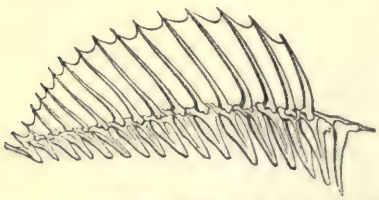


Fig. 193.—Dorsal Fin.

* These scientific terms are both derived from Greek words, signifying, in the one case, fins of sharp or spinous rays, and in the other, fins soft or of flexible rays.

CARTILAGINOUS FISHES.

From the peculiar structure of the skeleton, these form an interesting group, holding a place between the Cuttle-fish, in which there is but the rudiment of a skeleton, and the osseous fishes, in which the vertebrated structure in this class of animals reaches its full development. Among them there is great diversity. One little fish, of rare occurrence, the Lancelet (*Amphioxus lanceolatus*), which is not much more than an inch in length, has no skeleton, properly so called, but merely a membranous thread; in the Lamprey the divisions of the vertebræ are marked, so that they resemble beads placed on a string; in the Shark and the Sturgeon, the divisions of the vertebræ are complete.

Petromyzidæ.*—The family of the Lampreys (*Fig.* 194)

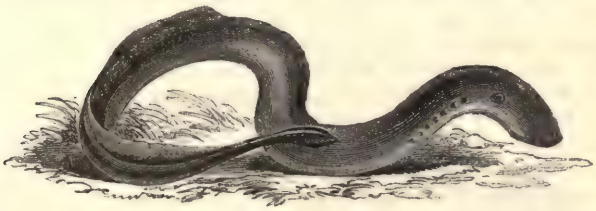


Fig. 194.—River Lamprey.

comprises the Lancelet, the fish just mentioned. Some of them dredged up in deep water, off the southern coasts of England, by Mr. MacAndrew, were exhibited by Professor Edward Forbes at the Southampton meeting of the British Association, September, 1846. They have, ere now, been ranked with the Mollusca, and exhibit peculiarities of a nature so remarkable as to be objects of the highest interest to the

* That is, the family of the "Stone-suckers," an appellation bestowed on them because, by means of their circular mouths, they can adhere to stones. Like other terms, it is derived from two Greek words.

comparative anatomist. These little fishes had devoured some larger ones of a different species, which had been confined in the same vessels with them, eating off their bodies what they required at one time, and returning, in the Abyssinian fashion described by Bruce, for another supply when wanted.

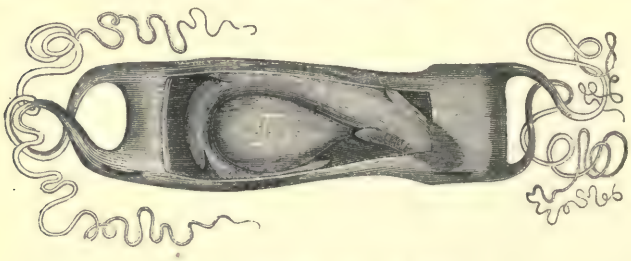


Fig. 195.—Egg-bag, with young Shark.

Squalidæ, Raiidæ.—The Sharks and the Rays, though differing so much in external form, belong to a group of fishes of which the gills are fixed, and the water, passing through the mouth, escapes from the gills by a series of longitudinal incisions. The ova, which are few in number, are not deposited on the sand or gravel, but each egg is enclosed, for greater safety, in a horny case, attached by long tendrils to the larger sea-weeds; and among the Sharks of the largest size, some bring forth their young alive. The empty egg-cases are frequently found on the sea-shore, and are well known by the name of "sea-purses," "mermaids' purses," and other local terms. The longer and narrower-shaped (*Fig.* 195) belong to the Sharks and Dog-fishes; the broader and shorter ones to the Skates or Rays. Water is admitted into them by means of slits or openings at each end of the purse. In two large clusters* dredged up in Strangford Lough, and sent to the Belfast Museum, the cases were obviously of three very distinct ages, the most recent being yellowish, semi-transparent, and the contents resembling those of a newly-laid hen's egg. Our figure, which is copied from that given by Mr. Yarrell, represents the case laid open, and the young Dog-fish attached to the "yolk," or membranous bag of nutriment, which is gradually absorbed as the growth proceeds.

* They were regarded as the ova of the Large-spotted Dog-fish.—W. Thompson, in Annals Nat. Hist. vol. xiv. p. 23.

The history of fishes furnishes many curious examples of certain kinds being held in high estimation in some places as food, and quite despised in others. This is the case with the Rays, of which there are eight native species. In the London market they are much valued, and in some parts of the coasts they are considered delicate and well-flavoured; while, in other localities, they are not used at all, or employed only as bait for catching crabs and lobsters. Colonel Montagu mentions a similar fact respecting the Sand-eel, known as the Sand Launce (*Ammodytes Lancea*). At Teignmouth it was in great request as food, while on another part of the south coast of Devonshire it would not be eaten even by the poorest people.

The Dog-fishes of our own coasts belong to the family of the Sharks (*Squalidæ*). In these rapacious fishes, "as among the truly predacious birds, the females are larger than the males; and almost all the species have received some name resembling Beagle, Hound, Rough Hound, Dog-fish, Spotted Dog, &c., probably from their habit of following their prey, or hunting in company or packs. All the Sharks are exceedingly tenacious of life. Their skins, which are of very variable degrees of roughness, according to the species, are used for different purposes; in some instances by cabinet-makers, for bringing up and smoothing the surfaces of hard wood."*

The Small-spotted Dog-fish (*Scyllium Canicula*, *Fig.* 196),

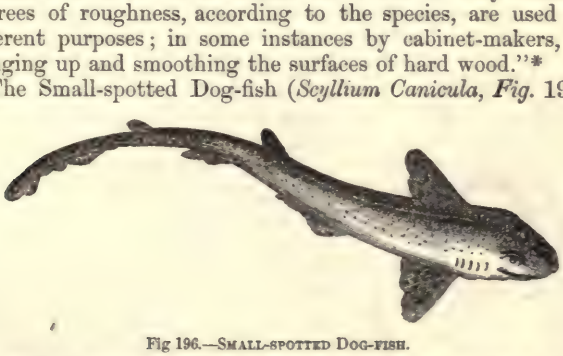


Fig 196.—Small-spotted Dog-fish.

the species most abundant on our shores, is an object of great dislike to fishermen, who try in various ways to avenge the injury which they believe it causes to their fishing. In tropical seas, the capture of the White or of the Blue Shark, the terror of mariners, is always to them a source of great exultation. The first act of the sailors, when their enemy is hauled up on

* Yarrell, vol. ii. p. 369.

the deck, is to chop off its tail, as danger is to be apprehended from the great strength with which it is used. Captain Basil Hall gives a most animated and seamanlike description of the entire scene.*

Some of the Sharks attain a great size. The Basking Shark, a species found off these coasts, has been known to measure thirty-six feet in length, and is one of the largest of the true fishes.† The Blue Shark has been celebrated for its affection for its young; and the belief yet prevails that the young are accustomed to seek safety from danger by entering the mouth of the parent fish, and taking shelter in its belly. That they have been found alive in the stomach, is admitted; but that they went there voluntarily, or for safety, seems more than doubtful.‡

A beautiful example of beneficent design is afforded by a peculiarity of structure observable in the young of Sharks and Skates, whilst still imprisoned in the egg-case. From the gills there are projecting filaments; each of these contains a minute blood-vessel, and serves thus to expose the blood to the purifying action of the water within the horny egg-case. These appendages, like those of the Tadpole hereafter mentioned, are only temporary; but they fulfil, at an early period of growth, the function which is afterwards so efficiently performed by the gills.

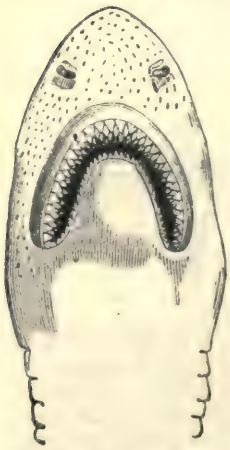


Fig. 197.—Head of Shark.

A more striking example of providential care is perhaps afforded by the arrangement which furnishes to the Sharks the means of keeping their formidable array of teeth (*Fig.* 197) fit to execute at all times their fearful office. They must be liable to be displaced and broken, and if fixed in sockets as our teeth are, and no means provided for a successive series, it is obvious that these formidable monsters of the deep would in time perish, from inability to seize their prey. But this

* Fragments of Voyages and Travels. Second Series, vol. i. p. 267.
† Yarrell, p. 396. ‡ Yarrell, p. 381.

is avoided by the teeth not being fixed in sockets, but attached to a cartilaginous membrane. The first row of teeth stands erect, the others are laid flat behind. The membrane continues to grow, and advance forward, the outer teeth drop out, the membrane itself is thrown off or absorbed, and the row which was originally second takes the place of the first, all the teeth in it standing erect, until, in the course of time, they make way for a third series, which is followed by others in succession.

STURIONIDÆ.—The only remaining fish we shall mention belonging to the cartilaginous group is the Sturgeon (*Acipenser Sturio*, *Fig.* 198), and it approaches to the other families of



Fig. 198.—STURGEON.

fishes in being oviparous, and in having the gills free. Its external appearance is striking, and the series of bony plates upon the surface of the skin is very remarkable.

In comparing the figures of the Sturgeon (*Fig.* 198), and of the Dog-fish (*Fig.* 196), with that of the Perch (*Fig.* 181), the appearance presented by the tail is extremely different. In the perch, the vertebral column ceases at the tail-fin, which if the line of that column were continued, would be divided by it into two equal parts. In the Sturgeon and others, the vertebral column is continued into the upper portion of that fin, and symmetrical appearance in the organ is therefore wanting. This is one of the obvious external characters by which the cartilaginous fishes may be distinguished from the osseous. In remote periods of the earth's history, this peculiarity of structure appears to have prevailed universally: it is found in every fossil fish whose remains are preserved in the magnesian limestone, and in strata of older formation.

The Sturgeon, when caught in the Thames, within the jurisdiction of the Lord Mayor, is considered a royal fish; the term being intended to imply that it ought to be sent to the king.* One taken in 1833, in Scotland, measured eight feet six inches in length, and weighed 203 lbs. Pennant mentions

* Yarrell, vol. ii. p. 362.

the capture of one in the Esk, weighing 464 lbs. In the northern parts of Europe, where the fish is more abundant, caviare is made of the roe of the female, and isinglass from the dense membrane forming the air-bladder.

OSSEOUS FISHES,

WITH THE RAYS OF THE FINS FLEXIBLE.

"Our plenteous streams a various race supply,
The bright-eyed Perch, with fins of Tyrian dye,
The Silver Eel, in shining volumes roll'd,
The Yellow Carp, in scales bedrop'd with gold,
Swift Trouts, diversified with crimson stains,
And Pikes, the tyrants of the watery plains."—POPE.

HAVING already noticed the Globe-fish (*Fig.* 179) and the Trunk fish (*Fig.* 180), which are members of a group connected by some points of structure with the osseous,* and by others with the cartilaginous fishes, we proceed to a small but interesting order (*Lophobranchii*) in which the gills are arranged like little tufts. To this belongs the Hippocampus or Sea-horse (*Fig.* 199), and the Pipe-fishes (*Syngnathidæ*), one of which has been noticed in connexion with its powers of movement (p. 206). This species is the largest of our native Pipe-fishes (*S. acus, Fig.* 182), and is furnished with a marsupial pouch. The idea of such a pouch is connected with that of the *female*. We know that it is thus the female Kangaroo carries and protects her young; but in natural history we are for ever meeting such strange occurrences, that it has been well said, "the naturalist has no need to invent; Nature romances it for him." In the Pipe-fish, contrary to what we find in other tribes of animals, the marsupial pouch belongs to the *male*. The sexes come together in the month of April; the ova pass from the female and are transferred into the sub-caudal pouch of the male, the valves of the pouch



Fig. 199.
HIPPOCAMPUS.

* They belong to the order *Plectognathi*, of Cuvier, characterized by having the jaws as if soldered together.

immediately closing over them. "In the month of July, the young are hatched and quit the pouch, but they follow their father, and return for shelter into their nursery when danger threatens."*

We have taken Pipe-fishes very abundantly by means of a small dredge towed over an expanse of mud-banks, thickly covered with grass-wrack (*Zostera*). Here there were doubtless small mollusca in abundance, affording a kind of food well adapted for the long tubular jaws of the Pipe-fishes.

Anguillidæ, the family of the Eels.—The pectoral fins in fishes are the representatives of the members which we call the arms in monkeys, and the wings in birds. The ventral fins are, in like manner, regarded as the representatives of the legs and feet. In the Eel tribe the ventral fins are wanting, and hence the term *Apodes*, a word signifying "without feet," has been applied to denote this peculiarity.†

The two species of Sand-eels are alike in their habit of burying themselves in the moist sands of the sea-shore; and we can speak from experience of the fun, frolic, and activity that prevailed when, on a summer night by a bright moon, some of our merry school companions turned up the sand, while others darted at each fish as it showed its silvery side for a moment in the light and then disappeared. At Dundrum Bay, County Down, and on other parts both of the Irish and English coast, they are taken in such abundance as to constitute a valuable article of food. The smaller and more common species (*Ammodytes Lancea*) is usually from five to seven inches in length, and offers a great contrast to another member of the same family, the Conger Eel of our coasts, which sometimes attains the weight of 100 or even 130 lbs., and measures more than ten feet in length.‡ There is a notion yet current that common Eels going into the sea remain there, and grow into Congers: an idea as unfounded as that of the child who supposes that ducks will grow into geese. The permanence of species is a truth which increasing knowledge every day confirms.

Three species of freshwater Eels are described as British. Some of these remain permanently throughout the year in certain ponds or rivers, and there deposit their spawn; but

* Owen's Lectures, p. 304.

† The Order is named *Malacopterygii Apodes*.

‡ Yarrell, ii. p. 306.

this is the exception to the rule. The Eels may, in general terms, be described as making a migration to the sea in the autumn of the year, for the purpose of spawning. It is at this time that they are taken in the largest quantities for the table. In the north of Ireland, one great place for their capture is Toome, on the Lower Bann, a river connecting Lough Neagh with the sea. The fishermen there assert that the Eels (*Anguilla acutirostris*) avoid the moonlight, and that "a run" of fish takes place only when the night is dark, and that even a flash of lightning will stop their progress. We are informed by Mr. Finiston, of Toome, that he has "completely stopped their progress, by placing three large lamps, so that the rays of light fell on the surface of the water, directly over the entrance to the net."* A "run," as it is termed, occurs only two or three nights in the season, but the quantity then taken is very considerable. So many as 45,000 small Eels have been taken in one night; and there are generally about sixty middle-sized Eels and ten large to each thousand of small. They are taken in nets, which may be compared in shape to sugar-loaves with the tops cut off, each from fourteen to sixteen yards long, and placed between weirs. At an early period of the summer it is an interesting sight, at the Cutts, near Coleraine, on the same river, to mark the thousands of young Eels there ascending the stream. Hay ropes are suspended over the rocky parts to aid them in overcoming such obstructions. At such places the river is black with the multitudes of young Eels about three or four inches long, all acting under that mysterious impulse that prompts them to push their course onwards to the lake. "There is no doubt that Eels occasionally quit the water, and, when grass meadows are wet from dew or other causes, travel during the night over the moist surface in search of Frogs and other suitable food, or to change their situation."

Eels have been known to be frozen and again revive, yet they seem in other ways very susceptible of cold. They are not found in the arctic regions nor in the rivers of Siberia. In our latitudes they take shelter from the inclemency of the winter by burying themselves in the mud. But this does not always protect them. In February, 1841, during a hard frost, large quantities of dead Eels, of the common sharp-nosed

* The family of this gentleman were for many years the lessees of the fishery at Toome.

species, came floating down the Lagan, and were taken in great abundance about the quays and wharfs of Belfast. The temperature for three days, as observed by Mr. Thompson, was then 27½°, which was ten degrees higher than during three successive days in the preceding month, when none were known to have suffered from cold; but at the time the Eels were killed, a strong easterly wind dried up the moisture of the banks, and probably occasioned their death by the extreme cold arising from evaporation.* The Conger Eels near Cork seem to have suffered from a similar cause at the same time.†

Passing by the Remora (*Fig.* 192), the representative of another family (*Echeneidæ*), and whose singular sucking-disc, placed on the crown of the head, has been already referred to (p. 221), we come to a family (*Cyclopteridæ*) in which the ventral fins are not wanting, as in the Eels, but are united beneath the body and form a concave disc, by which the fish can with ease adhere to stones or other bodies. Of this group the Lump-sucker (*Cyclopterus lumpus*, *Fig.* 200) is the best



Fig. 200.—Lump-sucker.

known species, as his uncouth shape, red eyes, and body in which bright tints of blue, purple, and orange, struggle for precedence, arrest the attention of the most incurious. We have taken in rock pools the young fish when less than an inch in length, and by changing the sea-water regularly, have kept them alive for several days, and have thus had opportunities of observing the rapidity with which they could adhere

* Annals of Natural History, 1841, vol. vii. p. 75.
† F. M. Jennings, Idem. p. 237.

to the sides of the glass vessel in which they were kept, or cast themselves free and pursue their course. Many of these marine creatures are highly interesting objects for observation, and after being kept for a day or two, may be returned to the sea uninjured; so that death is not the necessary consequence of their temporary imprisonment.

Pleuronectidæ.*—To this family belong the Plaice (*Platessa vulgaris*, *Fig.* 201), the Flounder (*Platessa flesus*), the Sole (*Solea vulgaris*), and other well-known flat-fish. Few are perhaps aware of their importance, regarded merely in the light of a marketable commodity. It is stated that for Turbot (*Rhombus maximus*, *Fig.* 202) brought to the London market, the Dutch are paid £80,000 a-year; and that the Norwegians receive from £12,000 to £15,000, annually for sauce for this luxury, extracted from one million of lobsters taken on the shores of Norway. The Turbot is considered to have been the *Rhombus* of the ancient Romans; and Juvenal alludes in his "Satires" to one of enormous size, taken in the reign of Domitian, who ordered a consultation of the senate, to devise the best mode of bringing it to table:—

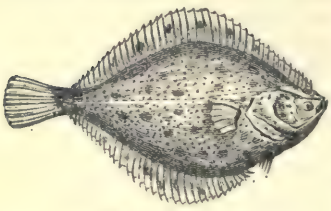


Fig. 201.—PLAICE.

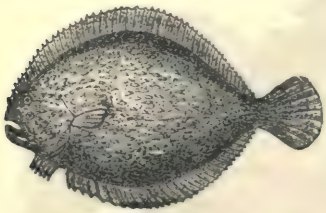


Fig. 202.—TURBOT.

> "No vessel they find fit to hold such a fish,
> And the senate's convoked to decree a new dish."

The next family (*Gadidæ*) contains a number of species which yield a most abundant supply of nutritious food, and give employment even on the British coasts to many thousands of hardy boatmen and mariners. It includes the Cod (*Fig.* 203), the Haddock, the Whiting, the Hake, the Ling, and others.

* The term is compounded of two Greek words, signifying to swim on one side, which is the well-known movement of these fishes.

The common Cod is so very voracious, that five-and-thirty crabs, none smaller than half-a-crown, have been taken out of



Fig. 203.—Cod.

the stomach of one fish.* But this very voracity makes the capture more easy, as almost any bait is acceptable. The great value of the Newfoundland Cod fishery is well known. The produce in 1836 was 860,354 quintals of fish,† each quintal being a hundred pounds. The oil which they yield is also a product of commercial and medicinal importance.

Clupeidæ, the family of the Herring.‡—Every reader of a newspaper must be familiar with the term, "Whitebait dinner,"§ as indicating a repast held in high estimation by the Lord Mayor and Aldermen of London, and by the learned Fellows of the Royal Society; and for which the ministers of the Sovereign pay annually a visit to Blackwall. This little fish (*Fig.* 204), so prized for its delicious flavour, was for-



Fig. 204.—Whitebait.

* By Mr. Couch. Yarrell, vol. ii. p. 145.

† Penny Cyclopædia.

‡ In the Cod, the Haddock, the Whiting, and other fishes belonging to the families we have been considering, the ventral fins are immediately below the pectorals. In the Herring, the Salmon, the Pike, and others belonging to families now about to be enumerated, the ventral fins are attached to the abdomen, and are situated far behind the pectorals. This circumstance enables us to divide such of the soft-rayed fishes (*malacopterygii*), as are possessed of ventral fins into two groups—the *abdominal* and *sub-brachial*, according to the situation of the fins.

§ "Feasts which would have made the ichthyophagous epicures of old die of envy."—Forbes and Spratt's Lycia, vol. ii. p. 91.

merly supposed to be the young of the Shad, but has now had its claims established by Mr. Yarrell to rank as a distinct species (*Clupea alba*). The Sprat (*Clupea sprattus*), another member of the same family, is valued, not so much for its delicacy as for its extreme abundance. It is taken during the winter months; the coasts of Kent, Essex, and Suffolk being those which are most productive. It is not used only as an article of food; after that demand has been fully supplied, the numbers are so great that the fish is used as manure. Many thousand tons are in some seasons sold to farmers, at sixpence to eightpence per bushel, for this purpose; forty bushels of Sprats being spread over an acre of land.*

The Pilchard (*Clupea pilchardus*), another of the family, is even more important. The number of persons to whom this fishery gives employment on the Coast of Cornwall has been estimated at 10,521; and the capital invested in boats, nets, and cellars for curing, at £441,215. The quantity taken is sometimes almost incredibly large. "An instance," says Mr. Yarrell, "has been known where ten thousand hogsheads have been taken on one shore, in one port, in a single day; thus providing the enormous multitude of twenty-five millions of living creatures drawn at once from the ocean for human sustenance." † The vast multitudes in which they occasionally appear realize the description of the poet:—

> "Forthwith the sounds and seas, each creek and bay,
> With fry innumerable swarm, and shoals
> Of fish that with their fins, and shining scales,
> Glide under the green wave, in sculls that oft
> Bank the mid sea."—MILTON.

Ranking still higher as an object of national importance is the Herring fishery, which gives occupation to thousands around the British coasts, and supplies to hundreds of thousands a cheap and favourite article of diet. The space to which we

* Yarrell.

† This calculation is made on the supposition that each hogshead contains 2,500 fish, which is about the average quantity. It is stated by R. Q. Couch, Esq., in a paper read by him before the Penzance Natural History and Antiquarian Society, that the number of hogsheads exported for the last ten years amounts to 176,168, and upwards of a third more is used for home consumption. During the present year, 33,959 hhds. have been exported—3,052 of which were sent to Genoa; 8,499 to Leghorn; 1,368 to Civita Vecchia; 13,309 to Naples; and 7,731 to the Adriatic.—*Penzance Gazette*, 10th Feb., 1847.

are necessarily restricted compels us to limit our notice of this well-known fish to one single point in its economy—its appearance on our coasts.

By Pennant, the approach of the Herring (*Clupea harengus*) has been described as that of a mighty army, which, coming from the arctic circle, divides at the Shetland Isles into two great bodies, one of which fills the creeks and bays of the east coast of Britain, while the other, passing along the west, separates towards the north of Ireland into two divisions—"one of which takes to the western side, and is scarcely perceived, being soon lost in the immensity of the Atlantic; but the other, which passes into the Irish Sea, rejoices and feeds the inhabitants of the coasts that border on it."

This account, though circumstantial, is altogether incorrect. The Herring does not abound in the arctic seas; and the division of the mighty army into brigades which pursue their way along the eastern and western shores, is purely imaginary. The Herring does perform a migration, but of a limited range. It comes to the shores for the purpose of spawning; the increased temperature and greater supply of oxygen being necessary for the development of the young. The ova being deposited, the Herring forsakes the shore for the deeper water, where it habitually dwells. It is not a visitant from a distant region, but a constant dweller in our own seas. It comes to the coast for a specific purpose, and that purpose being fulfilled, it again retreats to the deep water.

The Pilchard was, like the Herring, supposed to migrate from remote seas. Modern research has stripped the history of both fishes of much that was marvellous; but the mere emotion of wonder which is thus destroyed, is, on a little reflection, succeeded by one of a deeper, more reverential, and more abiding character. Under the impulse of the law by which certain species of fishes are, at successive seasons, impelled to approach the shores, the most effectual means are provided for the continuance of each of the several kinds; and while the perpetuation of the species is thus secured, man is furnished with a varied and successive supply of food, abundant, nutritious, and brought from the depths of the ocean within the sphere of his activity and skill. This constantly-recurring, yet ever-varying phenomenon has in its nature nothing of chance. It is a beneficent law, and reveals a beneficent Author.

Salmonidæ.—The Salmon is the acknowledged head of a well-known family of fishes. Among them is one that by common observers is referred to a different race, and is not unfrequently called the "Freshwater Herring." We refer to the Pollan (*Fig.* 205), an Irish species found in Lough Derg,

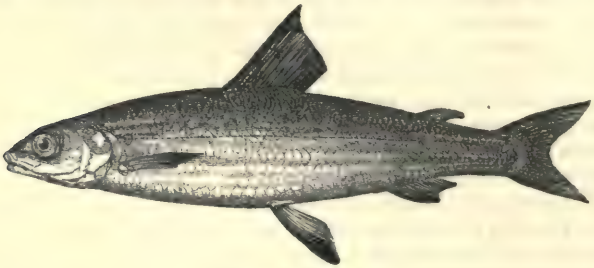


Fig. 205.—Pollan.

Lough Erne, and Lough Neagh, and first described by Mr. W. Thompson, as distinct from other species of the same genus in Lochmaben, and in the Cumberland lakes.* It approaches the coasts in large shoals, not only during spring and summer, but when the autumn is far advanced. In September, 1834, the greatest "take" of Pollan ever recollected at Lough Neagh took place, where the Six-mile-water enters the lake. "At either three or four draughts of the net, 140 hundreds,—123 fish to the hundred †—or 17,220 fish were taken. More were taken at one draught than the boat could with safety hold, and they had, consequently, to be emptied on the neighbouring pier. They altogether filled five one horse carts, and were sold on the spot at the rate of 3*s*. 4*d*. a hundred, producing £23 6*s*. 8*d*. They are brought in quantities to Belfast, and when the supply is good, the cry of 'fresh pollan' prevails even to a greater extent than that of 'fresh herring,' though both fishes are in season at the same period of the year."

In the nets with the Pollan are taken the Common Trout (*Salmo fario*) and the Great Lake Trout *Salmo ferox*). There

* The local name is Pollan, which has been retained in the scientific appellation, *Corregonus Pollan*. The information given respecting the fish is entirely derived from Mr. Thompson's researches, as republished in Yarrell's Fishes, 2d edition, vol. ii. p. 156. The figure is copied from that originally published in Annals of Natural History, vol. ii.

† The English long hundred is six score, or one hundred and twenty.

is a variety of these, not a distinct species, called in the neighbourhood of Lough Neagh the Gillaroo Trout, and said by common rumour to have a gizzard like that of a fowl. This notion must have originated in common observers having mistaken for a gizzard the skin of the stomach, which becomes hardened, possibly from the large numbers of a univalve shell (*Paludina impura*) used as food. The Great Lake Trout sometimes exceeds a yard in length and thirty pounds in weight. The large individuals are known at Lough Neagh by the name of *Buddaghs*, and the smaller as *Dolachans*.

Among the delightful fictions of the Arabian Nights' Entertainments is one of a lake, in whose waters were fishes of four different colours. Local causes seem to act upon the colour of the common Trout, so as to produce effects scarcely less surprising. This fish is distinguished for its bright and speckled skin; but we have seen, at Lough Katrine, Trout so black, that they seemed as if they had gone into mourning. The author of "Wild Sports of the West" mentions a similar circumstance with regard to the Trout of a small lake in the county of Monaghan, the water being bounded on one shore by a bog, and on the opposite by a dry and gravelly surface. On the bog side the Trout are dark and ill-shaped; on the other they are beautiful and sprightly, like those inhabiting rapid and sandy streams. "Narrow as the lake is, the fish appear to confine themselves to their respective limits—the *red* Trout being never found upon the bog moiety of the lake, nor the *black* where the under service is hard gravel."

But the brief space which we can devote to the *Salmonidæ* renders it needful that we should proceed at once to the most important of the family, the Salmon (*Salmo salar*).

During the floods of winter and early spring, this fish descends the river to the sea, lean and ill-conditioned, and returns in a few months, plump, well-conditioned, and greatly increased in size, from the abundance of food derived from small crustacea, fishes, and other marine animals and their ova. It is on their return from the sea for the purpose of spawning that the Salmon are taken. This occurs during the summer and autumn months, the precise time being different in different rivers.

Impelled onwards by the instinct which prompts this migration, the Salmon endeavours to surmount all obstacles that lie in its course, and flings itself over ledges of rock ten

feet or more in height above the surface of the water. It is said that at the falls of Kilmorac, in Inverness-shire, the Frazers of Lovat, the lords of the manor, caused this power to be occasionally exhibited in a singular manner for the entertainment of their guests. On a flat rock at the south side of the fall, and close to the edge of the water, a kettle was kept boiling, and the company waited until a Salmon fell into the kettle and was cooked in their presence.*

We never witnessed the singular spectacle thus recorded, but can imagine nothing in its way more attractive than the drawing of the nets at the salmon fishery called the Cranagh, on the Lower Bann, about a mile below the town of Coleraine. As the fishermen pull the net nearer to the shore, the struggles of the fishes in their efforts to escape, and now and then the vigorous leap which sets a captive free, are in the highest degree exciting. During two days which we spent there in June, 1823, the value of the fish taken, estimated at one shilling per lb., exceeded £400. We were informed by a relative, who had at that time the care of the fishery, that on the 5th of July, 1824, four hundred Salmon were taken at one "haul," and three hundred and fifty at the next. The entire weight of the fish captured that day amounted to two tons.

The fish are packed in ice, and are thus brought to market in good condition. But several years ago, when this practice was unknown there, it is said that the enormous number of 1,500 Salmon were taken at a single pull, and sold in Coleraine and the neighbourhood for three farthings per pound.

It was formerly supposed that the young Salmon fry descended to the sea the same season they escaped from the egg, and returned later in the year, their growth having been extremely rapid. But by a number of experiments and observations, made with great care, and ingeniously varied, this has been proved by Mr. John Shaw not to be the case.† The young fry does not go down to the sea until after it has completed its second year, nor does it until then assume what Mr. Shaw terms its migratory dress.

What, then, is its appearance during the earlier period of its existence? From the time it is one inch in length it has —in common with different species of Trout—the lateral markings that have been considered as characteristic of the

* Mudie's British Naturalist.

† Transactions of Royal Society, Edinburgh, 1840.

Parr. These it retains until it has completed its second year, and reached the length of six or seven inches. These markings then disappear—the old name is laid aside with the old dress, and it is in future known, not as the Parr, but as the *Salmon smolts* or *fry*. The fish, therefore, which has hitherto been called the Parr, and believed to be a distinct species, proves to be merely the early state of the Salmon; and thus one name is struck from our list of native species.

A remarkable fact is mentioned by Mr. Shaw, that "the milt of a single male Parr, whose entire weight may not exceed one ounce and a half, is capable, when confined in a small stream, of effectually impregnating all the ova of a very large female Salmon."

The young fry are descending the rivers in March, April, and May—a fact referred to in popular couplets:—

"The floods of May
Take the smolts away."

They most generally return to their native rivers. The fishermen acquire such habits of quick and accurate observation, that they point out with facility one that is a stranger, and name, in most cases, the place from which it came. This we have repeatedly seen them do at the fisheries on the Bann, and so promptly and decidedly, as to show they entertained no doubt on the subject.

Esocidæ.—The Flying-fish is nearly allied to the present family, that which is represented by the Pike (*Esox lucius*). This is a strong, fierce, active, and voracious fish, of whose audacity many stories are told. Gesner relates that a Pike in the Rhone seized on the lips of a Mule that was brought to water, and that the beast drew the fish out before it could disengage itself.* "At Lord Gower's Canal at Trentham, a Pike seized the head of a Swan as she was feeding under water, and gorged so much of it as killed them both; the servants perceiving the Swan with its head under water for a longer time than usual, took the boat and found both Swan and Pike dead."

It was formerly a rare fish in these countries; so much so, that Edward I. fixed its value higher than that of Salmon, and ten times greater than that of the best Turbot or Cod; and, in the reign of Henry VIII., a large one sold for double the

* Yarrell, vol. i. All the information here given on the Pike is derived from that author.

price of a house Lamb in February, and a Pickerel, or small Pike, for more than a fat Capon.

"Pliny considered the Pike as the longest lived, and likely to attain the greatest size of any freshwater fish. Pennant refers to one that was ninety years old; but Gesner relates that, in the year 1497, a Pike was taken at Hailbrun, in Suabia, with a brazen ring attached to it, on which were these words in Greek characters: 'I am the fish which was first of all put into this lake by the hand of the Governor of the Universe, Frederick II., the 5th of October, 1230.' This fish was, therefore, 267 years old, and was said to have weighed 350 lbs. The skeleton, nineteen feet in length, was long preserved at Manheim as a great curiosity in natural history. The lakes of Scotland have produced Pike weighing 55 lbs. weight; and some of the Irish lakes are said to have afforded Pike of 70 lbs.

Cyprinidæ.—The family of the Carp includes the Minnow, the Bleak, the Rudd, the Bream, the Tench, the Gudgeon, and other well-known freshwater fishes. The Golden Carp (*Cyprinus auratus*)—Gold and Silver-fishes, as they are more generally called—has been originally imported into these countries, but authors are not agreed as to the precise year. The Carp (*Cyprinus carpio*) itself is also a naturalized species, but introduced at so remote a date that, in the "Boke of St. Albans," printed at Westminster in 1496, it is mentioned:—"The Carpe is a dayntous fisshe, but there ben but fewe in Englonde."

The Bream is in such repute on the Continent, that an old French proverb says, "he that hath Bream in his pond is able to bid his friend welcome." And it may be inferred from a couplet in Chaucer's Prologue to the Canterbury Tales, that the feeding and eating of Bream was more in fashion in the days of Edward III. than at the present time—

> "Full many a fair Partrich hadde he in mewe,
> And many a Breme, and many a Luce * in stewe."

To one class of our young readers, it may perhaps be more interesting to know that from the silvery-looking scales of this family of fishes, the material is derived for making the gorgeous necklaces of artificial pearl which are so temptingly displayed in the toy-shops.

* Pike.

SPINY-FINNED FISHES.

THE remaining fishes belong to Cuvier's first Order (*Acanthopterygii*). They have the skeleton of bone, and the dorsal fins, as already mentioned (p. 222), supported in part by rays which are spinous and undivided. In all of them the gills are arches, presenting the pectinated or Comb-like structure so well known in our most common and valuable fishes.

Labridæ.—The first family we shall mention is that of the Wrasse, of which there are many species possessing brilliant colours—blue, green, orange, and red—and one, a Mediterranean species, which has been taken on the English coast, has so many bright tints intermingled in his costume, that he is appropriately termed the "Rainbow Wrasse." The Ballan Wrasse (*Labrus maculatus*) is sometimes taken off the rocky parts of the coast of Down and Antrim, measuring about eighteen inches in length. We have heard it called in the Belfast market the "Old Wife." In Plymouth market, the females of the Blue or Grey Skate (*Raia batis*) are called "maids" and "good wives." We have already mentioned the Fishing Frog (*Lophius piscatorius*, p. 210), a species which belongs to another family (*Lophiadæ*), and stated that it is also called the Angler. But these are not its only names, for it has as many *aliases* as other persons of equivocal character, being known as the Sea Devil, and in Scotland by the expressive though not very euphonious, appellation of "Wide Gab."

Gobioidæ.—Among the Gobies and Blennies of this family, there is one species which brings forth its young alive, and is hence called the "viviparous Blenny." Some are remarkable for their tenacity of life.

Mugilidæ.—In connexion with the family of the Mullet, an interesting fact has been established—that the *Mugil chelo*, or thick-lipped Grey Mullet of Cuvier—a species of extreme rarity on the southern coast of England—is that which is most abundant on the eastern shores of Scotland, and also along the eastern coast of Ireland. In the Bay of Belfast they are very plentiful, especially where the waters of the river Lagan mingle with those of the sea. Mr. Thompson states that, on 1st of

May, 1838, 7 cwt. of these fish were taken at a single draught of the net; and on the same night 9 cwt. were secured by the crew of another boat. A Mullet of large size will occasionally weigh so much as 10 or 12 lbs.; and one specimen is recorded as being so much as 14¾ lbs.*

The Mullet was believed by the ancients to be the most innocent of fish, and one that did not select as food anything that had life. But the Grey Mullet of Belfast Bay has habits so very much the reverse, that Mr. Thompson remarks, after an examination of the stomachs of many individuals, that they presented "many hundred-fold greater destruction of animal life than he had ever witnessed on a similar inspection of the food of any bird or fish. From a single stomach he had taken as many univalve and bivalve mollusca as would fill a large-sized breakfast cup; so that one of these stomachs may justly be regarded as quite a storehouse to a conchologist." In clear moonlight, and by day, Mullet of every size often clear the net, sometimes springing five or six feet over it, and when one has set the example, nearly all are sure to follow it. Having surmounted the meshy barrier, they sometimes take two or three additional leaps, and skim the surface beautifully, before again subsiding beneath it.

Tænioidei.†—We shall not dwell on the family of the Riband-shaped fishes, as it contains but about half-a-dozen of native species, and but little is known respecting their habits; we shall merely quote one fact to show how appropriate is their

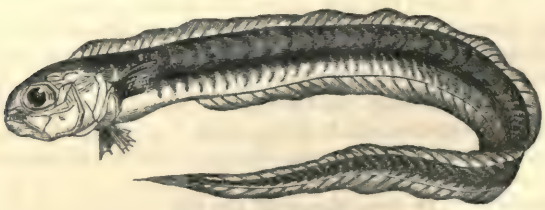


Fig. 206.—Red Band-fish.

name. A specimen of the Red Band-fish (*Cepola rubescens*, *Fig.* 206), as we are informed by Mr. W. Thompson, was, in

* On Fishes new to Ireland—Annals of Natural History, July, 1838. From this paper the information here given on this Mullet is extracted.

† The term denotes, like a band or stripe.

November, 1837, when penny postages were unknown, sent to him through the post-office, although nineteen and a half inches long; it was folded up like a riband, and passed in a franked letter of the ordinary size and legal weight—under an ounce.* A dead specimen of another species was picked up on the beach at Cairnlough, County Antrim, in 1836, by Dr. J. L. Drummond, author of "Letters to a Young Naturalist," &c., and being transmitted to Belfast, was found to be so perfectly unique as to require the establishment of a new genus for its reception. Some of the young for whose use this little book is especially written, may yet, in like manner, be so fortunate as to enrich our Fauna with species of which no other specimens are known to be extant. †

Scomberidæ.—The next family contains the Opah, the Dory, and the Sword-fish, all of which have been already mentioned (pp. 217, 220). To this belongs the Pilot-fish (*Naucrates ductor, Fig.* 207), celebrated for its attendance on

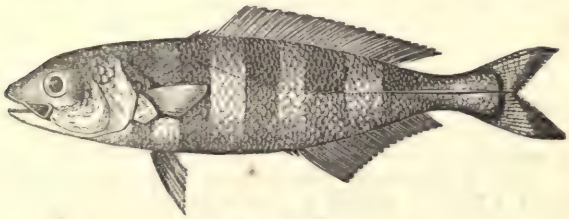


Fig. 207.—Pilot-fish.

the large Sharks, and supposed by the ancients to have pointed out to navigators their desired course, and borne them company during their voyage. Here also must be placed the Bonito (*Thynnus pelamys*), one of the ruthless pursuers of the Flying-fish; and the Tunny (*Thynnus vulgaris, Fig.* 208), a fish of large size, though here represented by a very diminutive figure. One killed at Inverary weighed 460 lbs., and measured



Fig. 208.—Tunny.

* Magazine of Natural History, 1838.

† It was described and figured by Mr. W. Thompson, in the Transactions of the Zoological Society, vol. ii.; the species being named in honour of the discoverer, *Echiodon Drummondii.* Another dead specimen was found on the coast of the County Kerry 23rd January, 1852.

seven feet ten inches in length. These fish visit the shores of the Mediterranean in great shoals, and give origin to an extensive and valuable branch of commerce.

Both the species just mentioned swim near the surface, are great consumers of oxygen, and maintain a high temperature. The Tunny is always spoken of by the fishermen of the Mediterranean as warm-blooded; and Dr. Davy* mentions, that he has known the temperature of the Bonito to be 99°, when the water at the surface of the sea was only 80°·5. We have here, therefore, a curious example of a fish with blood as warm as that of a man.

Highly prized though of so much smaller dimensions, is the Mackerel (*Scomber scomber*) of our own shores. Mr. Yarrell states that the success of this fishery, in 1821, was beyond all precedent. "The value of the catch of sixteen boats from Lowestoffe, on the 30th of June, amounted to £5,252; and it is supposed that there was no less an amount than £14,000 altogether realized by the owners and men concerned in the fishery of the Suffolk coast." A favourite bait for this fish is a slip of red leather or scarlet cloth; and a scarlet coat has therefore been called a Mackerel bait for a lady.

Sparidæ.—The sea Breams are furnished with strong jaws, and a great profusion of rounded teeth, by means of which they grind down the shells of the mollusca on which they feed. The Stickle-back (*Gasterosteus*, *Fig.* 187), and the Gurnard (*Trigla*), exhibit a peculiarity of a different kind. The head appears as if mailed or armed, and hence the term *Loricati*, indicating this peculiarity, is that by which they are distinguished. The species known as the "Fifteen-spined" (*ante*, p. 214), inhabits the sea, and is apparently fond of coming to the surface in fine weather, for we have taken it in a small towing-net, and on one occasion we saw it captured by a sudden plunge of the hand into the water. The Gurnards emit a peculiar sound when taken from the water; and hence one of them bears the appellation of "the Piper," and another that of the "Cuckoo Gurnard." †

The *Dactylopterus* of the Mediterranean (*Trigla volitans*,

* Researches, Philosophical and Anatomical.

† The "Drum-fish" of the United States is so called from its loud drumming noise. It is sometimes found three feet in length, and 35 lbs. in weight: in calm weather the sound which it emits is heard at a considerable distance.

Linn., *Fig.* 209) is a very singular and beautiful species, swimming in shoals, and sometimes rising out of the water in the manner of the Flying-fish, expanding at the same time its pectoral fins, which are large and transparent, of an olive green, with numerous bright blue spots.

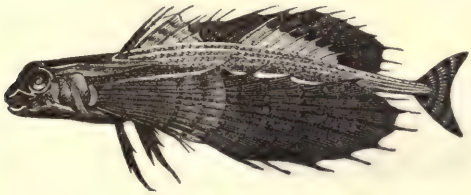


Fig. 209.—Dactylopterus.

Percidæ.—The last family we shall mention includes the Perch (*Perca fluviatilis*), and also the true Mullets of the Mediterranean; one of these, the striped Red Mullet (***Mullus surmuletus***), is a constant inhabitant of the southern shores of England. So much were they prized by the Romans, that a Mullet of six pounds weight is said to have been sold for a sum equal to £48; one still larger, £64; and even £240 were given for three of very unusual size, procured on the same day, for a repast of more than usual magnificence. The Perch is common throughout all the temperate parts of Europe, and is one of the most beautiful of all our freshwater fishes. The bright vermilion of the tail and lower fins contrasts strikingly with the markings and tints of the other portions of the body. It is a bold and voracious fish. Mr. Jesse tells us that he had placed some Perch in a vivarium (an artificial pond), and in a few days they came freely and took worms from his fingers.

It is interesting, in regarding the class of fishes, to contemplate the variations of structure which connect it with other groups, both of higher and of lower rank in the animal kingdom. We have seen (p. 223) that one small fish—the Lancelet—has been described as a mollusk. There is another—the Lepidosiren—which has been regarded as a reptile. Perfect unanimity does not prevail among naturalists with regard to its true place, but, following Professor Owen, we include it among the fishes. Of this animal two species are at present known—one found in the river Gambia, the other

in the Amazon. That of the Gambia (*L. annectens, Fig.* 210) inhabits a part of the river which overflows extensive tracts. Such individuals as do not follow the retreating waters, escape from the scorching rays of the African sun by burrowing in the mud, which is soon baked hard above them. There they remain, in a torpid state, until the return of the rainy season again awakes them to activity.*



Fig. 210.—LEPIDOSIREN.

We have endeavoured, with great brevity, to exhibit one class out of the many by which "the world of waters" is peopled. But our knowledge of the recent tribes is imperfect unless we add to it that of the extinct; and, accordingly, the study of the fishes found in a fossil state is a subject of high philosophical research, involving as it does, the question not only of what were their forms, but what were the conditions under which they existed. To this inquiry M. Agassiz, of Neufchatel, has devoted himself; and, in the vast series of investigations which it required, has combined the discriminating eye of the naturalist and the profound generalizations of the philosopher. By him all fossil fishes are arranged in four primary groups, according to the form of their scales:—

1st, *Ganoid*, with scales shining, as the Sturgeon.
2nd, *Placoid*, with scales broad-plated, as Sharks and Rays.
3d, *Ctenoid*, with scales comb-shaped, as the Perch.
4th, *Cycloid*, with scales of circular or smooth edges, as the Cod and Herring.†

The researches of Agassiz have led him to infer, that there

* For details connected with its organization, *vide* Professor Owen's Lectures, and Memoir in Trans. of Linn. Society, vol. xviii., part iii. It is regarded by him as the representative of a distinct order—*Protopteri*—occupying a position between the one containing the Sturgeon and that with the Sharks and Rays.

† These terms are all derived from the Greek; the literal meanings being nearly those which are here given.

is a constant correspondence between the characters of the scales and the internal organization of the fish.

When the number of fishes now living and possessing scales of these different forms, is compared with the number of those which formerly existed, we find that species and genera, which in countless multitudes swam in the ocean which then covered our existing continents, have long since passed away. Those whose vestments of enamel have bid defiance to the hand of Time, exhibit, sculptured on their scales, ornaments of microscopic beauty and diversified pattern. As an example of the singular forms presented by some of these fossils, we shall quote one brief paragraph, descriptive of some of the fossil fishes of the Old Red Sandstone.

"A stranger assemblage of forms has rarely been grouped together;—creatures whose very type is lost—fantastic and uncouth, and which puzzle the naturalist to assign them even their class;—boat-like animals, furnished with oars and a rudder; fish plated over like the Tortoise, above and below, with a strong armour of bone, and furnished with but one rudder-like fin; other fish, less equivocal in their form, but with the membranes of their fins thickly covered with scales; —creatures bristling over with thorns; others glistening in an enamelled coat, as if beautifully japanned—the tail, in every instance among the less equivocal shapes—formed, not equally as it is in existing fish, on each side the central vertebral bone, but chiefly on the lower side, the bone sending out its diminished vertebræ to the extreme termination of the fin. All the forms testify of a remote antiquity—of a period whose 'fashions have passed away.' The figures on a Chinese vase or an Egyptian obelisk are scarcely more unlike what now exist in nature than the fossils of the Lower Old Red Sandstone."*

NOTE.—ON THE IMPROVEMENT OF FISHERIES, AND THE EDUCATION OF FISHERMEN.—In an economical point of view, Zoology could not be turned to better account than in the right direction and promotion of the fisheries.

* From a delightful and highly instructive volume, entitled, "The Old Red Sandstone, or New Walks in an Old Field," by Hugh Miller. The first chapter tells us that the author was himself a working man, and describes "the quarry in which he wrought." It was while labouring in that humble vocation that his attention was first roused to the fossils of the "Old Red Sandstone;" a formation with which his name is now indissolubly connected.

This was forcibly put forward by Mr. R. Ball, in 1839, in a lecture delivered before the Royal Zoological Society of Ireland,* in which he showed how much science might be made to conduce to the welfare of fishermen, by affording them information on the nature and habits of fish, their migration, and food, viewed in connection with the geological character of the coast. He at the same time proposed a plan for imparting to them scientific and practical instruction by means of nomadic or wandering schools.

Subsequently the application of science to our fisheries has been ably urged, both in London† and Dublin,‡ by that eminent naturalist, Professor Edward Forbes. He has shown that the North Atlantic Ocean may be divided into certain zoological provinces; that each province owes its characteristic features to geological changes which occurred in a certain order, and that "the dispositions of the great sea-fisheries of Europe depend upon the disposition of the existing zoological provinces of the European seas." To the last point the learned lecturer called particular attention, and strongly advocated scientific inquiry properly directed, and the training and instruction of fishermen, as suggested by Mr. Ball.

The great importance of this subject in its bearing upon the British fisheries, and more especially upon those of Ireland, gives additional interest to the following extract from the Thirteenth Report of the Commissioners of National Education in Ireland.

"VII. 33. The same practical character which we are anxious to give to our country schools, by the mixture of agricultural with literary instruction, we shall endeavour to give to such of our own schools as are situated on the coast, by uniting instruction more peculiarly applicable to maritime districts, with the ordinary school education. With the view of promoting this object, and of testing its practicability, we have made a larger grant towards the establishment of a school in the town of Galway, at the fishing station called the Claddagh. In this school it is proposed that the pupils shall devote a portion of their time to acquiring a knowledge of navigation and of the art of fishing, and shall be employed in manufacturing nets and the various other articles required by fishermen in their trade."

* Saunders's News Letter, 24th May, 1839.

† At the Royal Institution, 14th May; see Athenæum, 22nd May, 1847.

‡ Before Zoological Society of Ireland, Saunders's News Letter, 29th May, 1847.

CLASS II

REPTILIA.—REPTILES.

THE Class Reptilia constitutes another of the great groups of vertebrated animals. Respiration is effected in some of the Reptiles by lungs and gills; in others by lungs only. The blood is cold. The heart consists of three cavities. The young are produced from eggs.

The great majority of these creatures are regarded by man with suspicion and distrust; yet there is no class of vertebrated animals which presents the same variety of form and structure. Among quadrupeds, the tiny Field-mouse (*Mus messorius*) that suspends her nest from a blade of corn, resembles, in all essential points of structure, the ponderous elephant. Among birds, in like manner, the diminutive Wren claims a place in the same phalanx with the majestic Condor of the Andes. But who, except the naturalist, could venture to affirm that the flexile Snake should be class-fellow to the shell-covered Tortoise?

Reptiles are most numerous in the countries of the torrid zone, a few only being found in those of more temperate regions. It has been well remarked, that "they can more easily bear the rigours of a severe winter than suffer the absence of a hot summer." The number of living species which is known and described amounts to six hundred and fifty-seven. They are divided by Cuvier into four orders; and, although some changes have been proposed by naturalists whose opinions are entitled to great respect, it will better suit the simplicity which is desirable in an elementary work, to adhere to the former arrangement, and treat of them as Tortoises Lizards, Serpents, and Frogs.

The number of species belonging to each of these orders is very different, and may be thus stated: *—

Tortoises	(*Testudinata*)	69
Lizards	(*Sauria*)	203
Serpents	(*Ophidia*)	265
Frogs	(*Amphibia*	120
		657

It is interesting to remark the manner in which, according to Berghaüs, the number of species diminishes as we pass from the sunny regions of the East to the duller and more cloudy climes of Western Europe. Thus Italy with her islands can number forty-seven species; France has thirty-one; Great Britain, fourteen;† and Ireland, it may be added, not more than five.

It has been stated that the blood of reptiles is cold, or in other words, their power of producing animal heat is so feeble, that we do not notice any difference between the temperature of their bodies and that of the air or water by which they are surrounded. The same was observed in the preceding group of cold-blooded Vertebrata—the fishes—but arose from a different cause. In the fishes the blood is imperfectly aërated, owing to the small quantity of oxygen with which it comes in contact in the gills. In the highest of the reptile tribes, which breathe exclusively by lungs, these organs are supplied with only a portion of the blood that has circulated through the veins; the other portion is returned into the circulation without being purified by exposure to the air. The arteries consequently contain a mixture of blood rendered impure by its previous circulation, and blood recently aërated in the lungs.

* Berghaüs and Johnston's Physical Atlas, from which admirable work all the information here given, as to the distribution and number of species, is derived.

† Namely, two Turtles, two Lizards, one Blind-worm, two Snakes, two Frogs, two Toads, and three Newts

In a Memoir read before the Royal Society, by Mr. Higginbottom, entitled, "Researches to determine the number of species and mode of development of the British Triton, the author states, that only *two* species of Tritons or Newts are met with in England, and that the animals require four years to attain their full growth. "The Triton," he remarks, "possesses the power of reproducing its lost limbs, provided the temperature be within the limits of 58° and 75° Fahrenheit; but at lower temperatures, and during the winter, it has no such power."—Athenæum, April 3, 1847; Annals of Natural History, July, 1847.

"Hence," says Professor Bell, "arises the circumstance that these animals have what is called cold blood; for, as it is from respiration that the blood derives its heat and the temperature of the body is thereby sustained, in animals which have more perfect respiration, it follows that where this function is but imperfectly performed, the animal heat, muscular force, and all other functions dependent on respiration will be diminished."*

In the last class to which our attention was directed—that of fishes—the circulation throughout life was suited to their residence in water. The first we shall notice in the present class are likewise fitted for aquatic respiration. We shall next proceed to those which in their very early stages breathe by gills, but afterwards by lungs; and thence pass on to those which at all periods possess aërial respiration.

Order I.—AMPHIBIA.

"The swimming Frog, the Toad, the Tadpole, the Wall-Newt, and the water."—Shakspeare.

The Amphibious Reptiles (order *Batrachia*† of Cuvier) may be separated into two divisions—those which possess both lungs and gills throughout the entire period of life, and those which have gills in their young state, and acquire lungs as they approach maturity.‡ The former group possesses some animals of very singular structure and habits; as the Proteus, which inhabits subterranean lakes in the Tyrol, the Axolotl

* History of British Reptiles—Van Voorst; another of that attractive series of works illustrative of the natural history of these countries. In the opinion of the learned author of that work, the structural peculiarities of the Amphibia are such as to justify their being regarded as a *distinct class*, instead of being merely ranked as one of the *orders* in the class Reptilia. Mr. Jenyns has thus arranged them in his "Manual."

† From the Greek word signifying a *frog* (Lat. *Bâtrăchus*). The term Batrachian means, therefore, a frog-like animal.

‡ Those in which the gills are permanent are termed Perennibranchiate (Latin, *branchiæ*, the gills, and *perennis*, permanent, lasting, staying all the year round). Those in which the branchiæ disappear, are termed Caducibranchiate, the word *caducus* meaning perishable, falling of itself, &c.

(*Fig.* 211), the flesh of which is regarded as an article of luxury by the inhabitants of the city of Mexico, near to which it is taken. It is, however, to the latter group that we wish more particularly to call attention; for in the Frogs, Toads, and Newts of these countries, we have the opportunity of watching the successive steps by which they become fitted for breathing air, instead of continuing to use an apparatus adapted, like that of fishes, for aquatic respiration only.



Fig. 211.—Axolotl.

Let us give our attention, in the first instance, to the changes which take place in the common Frog, (*Rana temporaria*). The eggs are deposited at the bottom of a pool of water, each egg consisting of a black centre, surrounded by a covering of glutinous matter. This covering absorbs water; the mass swells, so that the central portions appear like black dots, separated from each other by a transparent jelly; and owing, as Professor Bell states, to some partial decomposition, and the consequent disengagement of a gas, the entire mass becomes lighter than the surrounding water, and rises to the surface. It is in this stage that we have taken some of the spawn, and kept it in glass vessels for the purpose of watching the subsequent changes, which are much influenced by the temperature of the apartment. When the little Tadpole has burst from its prison, the gills begin to develope themselves, and increase rapidly in size until they attain their greatest development. They are now objects of singular beauty viewed through the microscope; for such is their transparency that the course of every blood-globule, as it passes up or down the main stem, or enters the inlets presented by each leaf, is distinctly visible. The delight with which this spectacle is regarded by children, and the interest they henceforward take in the previously-despised Tadpole, are matters of which we can speak from personal experience. This period of expan-

sion is, however, more temporary than that of many of our cherished garden flowers. The tufted gills shrink in size, until, like the gills of fishes, they are concealed within the branchial sacs. The little Tadpole (*Fig.* 212) begins to feed on decaying vegetable matter; the tail has become a large and powerful organ for locomotion, and a rapid increase in the size of the body is perceptible. After a time the hinder feet become developed (*Fig.* 213); then the anterior extremities bud forth* (*Fig.* 214); the tail shrinks; the form of the perfect animal is assumed (*Fig.* 215); the remaining vestige of the tail disappears (*Fig.* 216); and instead of an aquatic animal breathing by gills, and subsisting on vegetables, we have a terrestrial animal, breathing by lungs and altogether carnivorous.



Fig. 212.



Fig. 213.



Fig. 215.

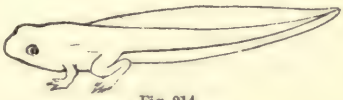


Fig. 214.



Fig. 216.

The food of the Frog consists of insects of various kinds and of small Slugs; the number which is thus destroyed is so considerable, that the Frog might prove a valuable assistant to the farmer or the gardener. The manner in which the food is taken is worthy of notice. In the Frogs, as in the Toad, the tongue is doubled back on itself. The point, covered with a viscid secretion, is thrown forwards upon the insect and drawn back again with such rapidity as scarcely to be detected without careful watching.†

In some of the countries of both temperate and tropical regions there are Frogs which, from their habitation, are called

* We are informed by a friend, who has watched the metamorphosis with great attention, that the left fore leg is perfectly developed before the other appears.

† Bell's Reptiles.

Tree-frogs (*Hylæ*, *Fig.* 217). They are described as beautiful and active little animals, not unlike in their colours to those of the trunks and foliage, and furnished at the end of their toes with small cushions or pads, by means of which they can adhere to smooth surfaces. Some of them utter a pleasing chirp, which in the cool evenings swells into a kind of concert, the Cicadæ and Crickets taking part in the performance.*



Fig. 217.—Tree-Frog.

The respiration of the Frog is not carried on by the lungs alone, but also by the skin; and in order that the skin may be always kept moist, and in a state fit to perform this important function, the creature is furnished with an internal reservoir of pure water, absorbed and there deposited when fluid is abundant, and given back to the skin when additional moisture is required. There is a peculiarity even in the pulmonary respiration: it cannot be carried on in the Frog by the expansion and contraction of the chest, for it is destitute of ribs. The air is taken into the mouth, and the nostrils and throat being closed, it is forced down into the lungs. As this movement can only be performed when the mouth is shut, the poor creature would perish for want of pulmonary respiration if gagged with the mouth open.†

The Frog is believed to have been introduced into Ireland in the early part of the last century. The common Toad (*Bufo vulgaris*) is there unknown, its absence being accounted for, according to popular tradition and song, by the malediction of St. Patrick. The smaller species, the Natter-jack (*B. calamita*), does not appear, however, to have been banished with the rest of "the varmint," as it is found in three or four localities in the County Kerry, especially at Rossbegh, a small inlet or creek of Dingle Bay. Both Frogs and Toads pass the winter in a state of torpidity.

* At Rio de Janeiro. Darwin's Journal, p. 34.

† Bell. Berghaüs and Johnston mention that the common Frog (*Rana temporaria*) is found on the Pyrenees at an elevation of 7,700 feet.

The remainder of the British Amphibia belongs to the family Salamandridæ, and consists of four species of Newts, of which one only (*Lissotriton punctatus*) appears to be generally distributed in Ireland, In the northern parts it is well known by the name of "Mankeeper," and is regarded by the uneducated with apprehension, from the erroneous idea that it is prone to jump down the throat of any one whom it may find sleeping.

The metamorphosis of the Newts is so similar to that of the Frogs, that any detail on the subject is unnecessary. The leaf-like tufts that float in the water (*Fig.* 218) are different in form, though alike in function. But it is not only in external figure that the changes of the amphibia are remarkable; those in internal structure are to the physiologist even more interesting. The important function of circulation must of course be adapted to that of respiration. Each change in the one necessarily involves a corresponding modification of the other. It is not our intention to go into any minute anatomical details; we would only refer to the accompanying figures to show the nature and extent of these internal changes. In the first (*Fig.* 219) the blood-vessels of

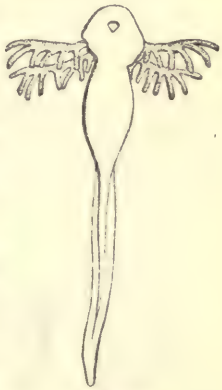


Fig. 218.



Fig. 219.

the Tadpole are shown in an early stage; the second (*Fig.* 220) in a more advanced state, and with those arteries which are to convey the blood to the lungs greatly increased in size.



Fig. 220.

In the third (*Fig.* 221) the gills have disappeared, and the respiratory circulation is carried on by the arteries of which the development was exhibited in the previous figure.

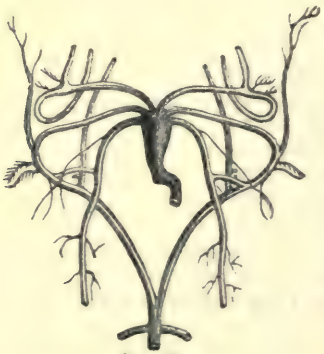


Fig. 221.

The Newts, like the Frogs and Toads, are carnivorous, preying upon aquatic insects, larvæ, worms, and mollusca; nor do the larger species hesitate at laying hold of and devouring their weaker and smaller brethren. The Tadpole of the Frog forms also an important item in their bill of fare.

When it is considered that all the amphibia are harmless to man, and many of them actually useful, by keeping in bounds the diminutive assailants of his crops and pastures, it may seem strange that they should have been so generally regarded as disgusting and pernicious. Perhaps no individual among them has been so slandered as the Toad; and if we did not know, in other instances, how imagination takes the place of reason, it might seem incredible that this unoffending reptile should have been regarded as "highly poisonous, and this not only from its bite—its breath and even its glance were fraught with mischief or death."* It was natural, therefore, that

* Bell's Reptiles.

Shakspeare, living at a time when such ideas were still current, should embody them in his writings, and speak of the Toad as "loathsome," "venomous," and "poisonous,"* should place it first in the cauldron of the witches, and add thereto,

"Eye of newt and toe of frog." †

Such records, "figuring the nature of the time deceased," are of high interest and value, for they serve most impressively to mark the varying phases of popular belief at different epochs. In one passage the poet has given us a singular though erroneous tradition, and a profound moral truth—

> "Sweet are the uses of adversity,
> Which, like the *toad*, ugly and venomous,
> Wears yet a precious jewel in his head."
>
> AS YOU LIKE IT, Act ii. scene 3.

There is evidence of the former existence in these countries of a gigantic reptile of the present order. From the peculiarly convoluted structure of its teeth, it has received from Professor Owen the highly descriptive appellation of Labyrinthodon: a term compounded of two Greek words, signifying "a labyrinth" and "a tooth." It has left the mark of its footsteps, resembling the impression of a hand, on the moist sand-beach of the ancient seas, which sand is now consolidated into what is termed "new red sandstone." The impressions vary in size, but those of the hind feet are invariably much larger than those of the fore. In some cases their length is so much as twelve inches, while that of the smaller is about four inches. At the Storeton Hill, near Liverpool, on the west side of the Mersey, similar marks have been found, along with those left by five or six smaller reptiles.

* "As *loathsome* as a toad."—TIT. AND. Act. iv. scene 2.
"As *venomed* toads."—*Third Part* K. HENRY VI. Act ii. scene 2.
"This *poisonous* hunch-backed toad."—RICHARD III. Act i. scene 3.

† For convenience of reference, the passages referred to are extracted:—

First Witch—"Toad, that under the cold stone
Days and nights hast thirty-one,
Swelter'd venom sleeping got,
Boil thou first i' the charmed pot!

Second Witch—Fillet of a fenny snake,
In the cauldron boil and bake:
Eye of newt and toe of frog,
Wool of bat and tongue of dog,
Adder's fork and blindworm's sting,
Lizard's leg and owlet's wing."

MACBETH, Act iv. scene 1.

Order II.—OPHIDIA.—SERPENTS.

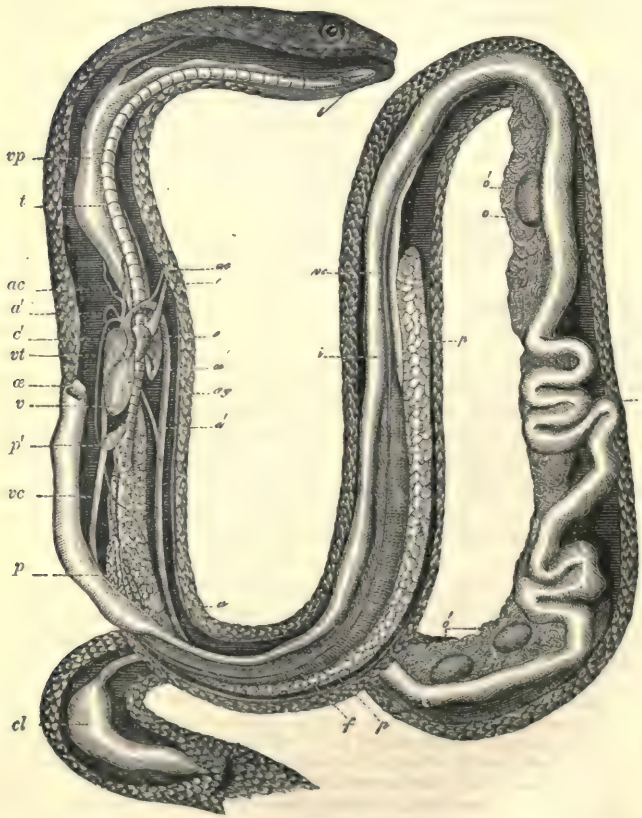


Fig. 222.—Anatomy of a Snake.*

The internal structure of one of the Serpents is represented in the preceding figure (*Fig.* 222). We shall only add, that

* *l*, tongue and glottis; *œ*, œsophagus, divided at *œ* to show the heart, &c.; *i*, stomach; *i'*, intestine; *cl*, cloaca; *f*, liver; *o*, ovary; , *o'* eggs; *t*, trachea; *p*, principal lung; *p'*, undeveloped lung; *vt*, ventricle; *c*, left auricle; *c'*, right auricle; *ag*, left aortic arch,; *ad*, right aortic arch; *a'*, *a'*, ventral aorta; *ac*, carotid arteries; *v*, vena cava superior; *vc*, vena cava inferior; *vp*, pulmonary vein.

in order to endow these tribes with the greatest possible flexibility, the number of joints in their spinal column is even greater than in the Eels. In the Rattle-snake (*Crotalus, Fig.* 223) there are about two hundred; and above three hundred have been counted in the spine of the Viper (*Natrix torquata*).* Thus furnished they can glide along with silence and rapidity, climb trees, and leap with considerable vigour and agility.



Fig. 223.—Rattle-snake.

The number of Serpents, like that of other reptiles, increases towards the torrid zone, while comparatively few are found in cold regions. They do not appear to advance so far northwards as Frogs and Lizards.

"One of the most curious facts in the distribution of Serpents, viewed in relation to different parts of the globe, is their total absence from the numerous isles of the Pacific Ocean—a phenomenon the more remarkable, since the neighbouring isles forming the great Indian Archipelago belong to those regions of the earth most abounding in Serpents. Another interesting fact is, that the Serpents, and indeed all the reptiles of America, are specifically different from those of the Old World; while, on the other hand, a great many birds and several mammiferous animals of North America are precisely the same as those of Europe and a great part of Asia."†

Some Serpents live amid the foliage of trees, some inhabit fresh waters, some poisonous tribes live in the seas of tropical Asia and New Holland, but by far the greater number are terrestrial. According to Schlegel, there are at present 265 known species, and of these only 58 are venomous; so that the proportion of the harmless ophidians to those which are

* Roget's Bridgewater Treatise, vol. i. p. 450.

† Schlegel, "Essai sur la Distribution Géographique des Ophidiens," as abridged in Berghaüs, Physical Atlas.

venomous is nearly as four to one. This is contrary to popular opinion, and it was especially so in the "olden time." Thus, whenever Shakspeare mentions one of those animals, it is always as a creature to be shunned as hateful or venomous:—

> "He is a very *serpent* in my way;
> And wheresoe'er this foot of mine doth tread,
> He lies before me."—KING JOHN, Act iii. scene 3.

The gigantic Boa-Constrictor belongs to those which are not venomous. It kills its prey by the enormous compression it exerts when coiled round the body of its victim, which it then proceeds to swallow entire. The teeth are sharp, point backwards, and thus retain the food. And here comes into use a curious and bountiful provision with which snakes are furnished. The lower jaw is not united to the upper; it is hung to a long, stalk-shaped bone, upon which it is moveable (*Fig.* 224); and this bone has also a power of motion, being attached to the skull by muscles and ligaments. By means of this apparatus, which is common to all true Serpents, they can swallow animals larger than themselves. This being done they remain in a quiescent state until digestion is completed, and the calls of hunger again excite them to exertion.

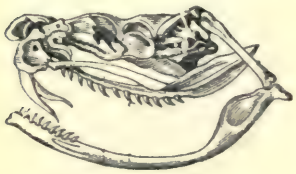


Fig. 224.—SKULL OF RATTLE-SNAKE.

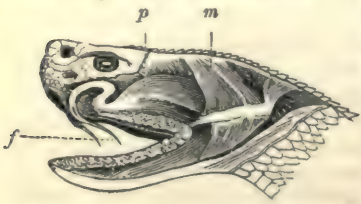


Fig. 225.—POISON APPARATUS OF RATTLE-SNAKE.*

In addition to this elaborate contrivance, the venomous tribes are furnished with poison-fangs, "constituting perhaps the most terrible weapons of attack met with in the animal creation"† (*Fig.* 225). They are two in number, fixed to the upper jaw, or, to use more precise language, one is fixed to

* Fig. 225.—*p*, poison gland; its duct terminates in the large moveable tooth or fang, *f*; *m*, muscles which raise the lower jaw and compress the poison gland.

† Jones's Outline of the Animal Kingdom.

each superior maxillary bone. When not in use, they lie flat upon the roof of the mouth, concealed by a fold of the skin. In each fang is a channel, which opens, not at the point of the tooth, but near to it, by a longitudinal fissure. Through this passage the poison flows. When the animal is irritated the poison-fangs are erected in a moment; and when they are struck into the victim, it is easy to imagine how forcibly the poison must be injected into the wound; for the powerful muscles which elevate the lower jaw serve at the same time to compress the poison-bag.

Behind the large poison-fang in actual use are the germs of several others, ready to supply its place if accidentally broken off, each of which is soon "adapted in all respects to take upon itself the terrible office of its predecessor."

The poison itself is neither acrid nor burning. On the tongue it only produces a sensation like that of fatty matter, and it may be swallowed without danger; but introduced into the blood in sufficient quantity, it causes death with fearful rapidity, though the power varies, according to the species, and other circumstances. To avoid such consequences, the best precaution is that which is adopted in these countries for the bite of a dog supposed to be mad: the immediate cutting out and cauterising of the wounded part.

In one genus of the poisonous Serpents there exists a provision which puts the unwary on his guard, and discloses the proximity of the dangerous reptile. We allude of course to the Rattle-snake (*Fig.* 223). Its tail is terminated by a series of horny rings, loosely put together, which rattle with the slightest movement of the animal, and even with the vibrations of the tail when the creature itself lies in concealment.*

Among the venomous Serpents is one which possesses a classical and historical interest, associated, as it is, with the death of Cleopatra—the Egyptian Naja or Asp (*Fig.* 226). It is at present much used by the Egyptian jugglers in their exhibitions. One of a nearly allied species, the Cobra-di-Capello, has a curious mark on the skin of the neck, not unlike a pair of spectacles. A specimen of this Snake was presented to the Belfast Museum, by Major Martin (now residing at Ar-

* The information here given respecting the poisonous Serpents is almost entirely derived from Jones's Outline, Carpenter's Zoology, and Milne Edwards' "Elémens de Zoologie."

drossan, Ayrshire), who narrated to us the following interesting occurrence:—While stationed in Ceylon, his servant one morning ran into his room and informed him that a favourite Hen was lying dead in her nest, and that the twelve eggs on which she had been sitting were taken away. Supposing it must have been by a Snake, immediate search was made throughout the hen-house and other adjoining premises, when a Cobra-di-Capello was found under a piece of wood, and was immediately killed; being opened, the eggs were found in its belly. Nine out of the twelve eggs were broken; the remaining three were immediately put under another Hen that was sitting, and in due time a chick was produced, and the race of the feathered favourite thus preserved from extinction.



Fig 226.—Egyptian Naja.

Some of the great Snakes found in India incubate, or sit on their eggs. This fact was observed in the case of a female (*Python bivittatus*) in the menagerie of the Museum at Paris. Her body was coiled round the eggs (fifteen in number), forming a cone, at the top of which was her head. The temperature of the body was sensibly augmented while incubation was going on, which lasted for nearly two months. During the whole of this period she ate nothing, but drank greedily several times. As soon as the young were hatched she left them to themselves, evincing no further affection for the offspring over which she had so sedulously brooded.*

The remains of Serpents of this tribe, and of that of the Boa-Constrictor, have been found in the London clay, thus proving the former existence in these kingdoms of reptiles which are now only known in tropical countries. No snakes

* Annales des Sciences Naturelles, tome xvi. p. 65. Quoted in Note to Jenyns's Edition of White's Selborne, p. 69.

of any kind whatever exist in Ireland. In England, the harmless tribes are represented by the Common or Ringed Snake (*Natrix torquata*), and the venomous by the Adder or Common Viper (*Pelius berus*). The injurious results of the bite of the latter reptile would appear to be much exaggerated. Professor Bell states that he has never seen a case which terminated in death, nor has he been able to trace to an authentic source the numerous reports of such a termination.

Both species lie torpid during the winter, concealed under hedges, or the hollow roots of a tree, or any other sequestered and sheltered situation. The numbers that thus remain coiled together are sometimes so considerable that Dr. Carpenter mentions an instance which came within his own knowledge, of 1300 Ringed Snakes being found in an old limekiln.* The return of a more genial season and a higher temperature again rouses them to activity. Hence the remark of the poet—

> "It is the bright day that brings forth the adder,
> And that craves wary walking."—SHAKSPEARE.

These reptiles possess, as is well known, the power of changing or casting off their skin. Before it is cast off—a process which appears to take place at uncertain intervals—the colouring is dull, and the animal seems blind. When the new skin is completely formed and hardened underneath, the old one bursts or splits asunder, about the neck, being removed as the animal passes through any tangled copse.

A remarkable difference exists between the Common Snake and the Viper with regard to the production of their young. The former is oviparous, and deposits from sixteen to twenty eggs, which are vivified by heat. The latter is ovo-viviparous; that is to say, the young are produced from eggs; but in the very act of deposition, the membranous covering of the egg is rent asunder, and the young—which vary in number from sixteen to twenty—come forth alive.

Dr. Clarke, in speaking of the Common Snake, remarks—"The movements of this species are highly elegant. Its course among grass or underwood is performed in a zigzag direction; the head and neck are thrust forward alternately to the right and left, while the rest of the body follows precisely the same course. In its progress the head pushes aside the blades of grass or other yielding bodies, and the remainder of the body

* Zoology, vol. i. p. 569.

follows without communicating any motion to them; and in this way a snake will often steal across a meadow, or through a thicket, unperceived by a person standing at a little distance."* In contrast with the clear and simple statement here given of the movements of the common English Snake, it is interesting to place the magnificent description so well known to every reader of "Paradise Lost":—

> "So spake the enemy of mankind, enclosed
> In serpent, inmate bad! and toward Eve
> Addressed his way; not with indented wave
> Prone on the ground as since, but on his rear
> Circular base of rising folds, that tower'd
> Fold above fold, a surging maze! his head
> Crested aloft, and carbuncle his eyes,
> With burnished neck of verdant gold, erect
> Amidst his circling spires that on the grass
> Floated redundant."—Book ix.

Like many other now exploded specifics, the flesh of Serpents, or the liquid, especially wine, in which they were infused, was held of peculiar efficacy for the cure of disease, and as an antidote to poison. These ideas, preposterous as they may now appear, were not discarded until the last century was far advanced. In Dr. Owen's work on Serpents, published in London in 1672, we are informed that "their flesh, either roasted or boiled, the physicians unanimously prescribe, as an excellent restorative, particularly in consumptions and leprosy."

There is another reptile equally inoffensive, and not less maligned than some already mentioned—the Blind-worm, or Slow-worm of Britain, described as the "eyeless venom'd worm" by Shakspeare. Yet it has in fact no poison fangs, and is naturally of so timid and gentle a disposition, that only under circumstances of great provocation will it attempt to bite. It is unknown in Ireland; but in Scotland we have seen it broken in two by the blow of a slight rod, thus illustrating the correctness of the Linnæan appellation—*Anguis fragilis*—the Fragile Snake.

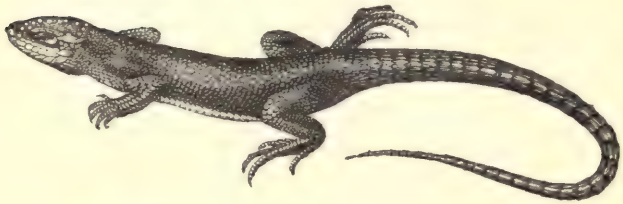
To the systematic naturalist this creature is interesting from its exhibiting in certain points the character of two distinct classes of reptiles. The body is destitute of legs, in that respect resembling the true Serpents, while at the same time the

* Magazine of Natural History, 1838, p. 479.

jaws and cranium are consolidated, thus resembling those of the Lizards.

The great altitude at which some Snakes are found is worthy of notice, as it necessarily involves their capability of living at a lower temperature than might have been expected. It is stated that two species of Viper, one of them the Common Adder of England, are found on the Alps at an elevation of 5300 feet; and the Blind-worm nearly as high as 6000 feet.

Order III.—SAURIA.—LIZARDS.



In this order the body and tail are elongated, the jaws are furnished with teeth, the skin is covered with scales, and the animals have generally four feet. About two hundred species are known, which are distributed by naturalists into nine or ten families, and numerous genera.

The flesh of many of the foreign Lizards, when cooked, is white, and is relished as very good food. Humboldt has remarked that all the South American species within the tropics, and inhabiting dry regions, are esteemed delicacies for the table. Their habits present considerable variety. Mr. Darwin mentions one (*Amblyrhyncus cristatus*) that swims out to sea at the Gallipagos Islands, and feeds upon a sea-weed that grows at the bottom; and another (*A. sub-cristatus*) that makes burrows on the land. He watched one of these for a long time while making its excavation. "I then," continues he, "walked up and pulled it by the tail; at this it was greatly astonished, and soon shuffled up to see what was the matter, and then stared me in the face, as much as to say, 'What made you pull my tail?'"

The genus which comprises the greatest number of species is that of the Iguanas (*Fig.* 227), which are found only in

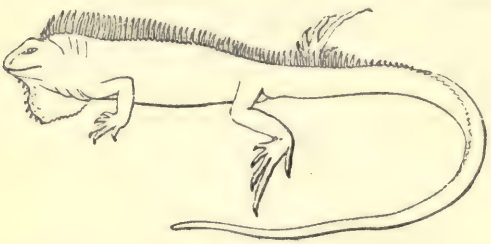


Fig. 227.—Iguana.

the New World. Some of these are so much as five feet in length, and the colour a beautiful green of a variety of shades. They have a singular crest along the back, and a hanging pouch, like the dewlap of oxen, under the chin. This pouch they have the power of inflating with air. They live among the branches of trees, and feed principally, but not exclusively, upon leaves and fruits. Eggs and insects form a portion of their diet.*

Darker in colour and more repulsive in aspect are the



Fig. 228.—Gecko.

Geckos (*Fig.* 228) or Nocturnal Lizards. "Though timid and harmless, they are always regarded by the vulgar as

* A gigantic fossil reptile discovered in the South of England, in 1834, by Dr. Mantell, is named the Iguanodon, from its resemblance in many points of structure to the Iguana.

venomous and highly dangerous. Besides the depressed form of the body, they are eminently distinguished by having the feet palmated, or rather lobed and dilated into discs." * In consequence of this peculiarity of structure they can ascend walls, and even run along ceilings. They lurk in crevices during the day, and come forth at night in pursuit of their insect food.

Perhaps, however, there are no reptiles to which a greater degree of popular interest attaches than to the Chameleons (*Fig.* 229). They are exclusively natives of the warm parts



Fig. 229.—Chameleon.

of the Old World, and exhibit several structural peculiarities. Like other Lizards they have five toes; but they are divided into two parcels, and thus adapted for climbing. The tail also serves as an instrument for prehension. The eyes have such independent powers of motion that they can be turned in the most opposite directions at the same time. The tongue is of great length, and is terminated by an adhesive disc, which they dart out with unerring aim at their insect prey. We have watched for hours their sluggish and almost inanimate appearance, though even at such times they occasionally manifest the singular changes of colour for which they are so celebrated. These, however, are not to the extent set forth in a well-known poetical composition, with which every school-boy is familiar; but after all allowance for poetical exaggeration, the phenomenon is sufficiently curious to have been for a long time one that naturalists were unable to explain. It was reserved for Milne Edwards to solve the problem. † He has shown that there exist, in the skin of these animals, two layers

* Swainson on Fishes, Amphibia, and Reptiles.

† Annales des Sciences Naturelles. January, 1834.

of membranous pigment, or colouring matter, so arranged that both may be visible at the same time; or that the lower layer may appear in varying proportions amid the upper; or that it may be altogether concealed beneath it. This mechanism is similar to that which exists in some of the Cuttle-fish, to whose changes of colour we have already referred (Part I., p. 190).

The Lizards, which are regarded as the true types or representatives of the order, do not belong to any of the families yet mentioned, but to the *Lacertidæ*. These have long, slender, forked tongues, and are the attractive and nimble reptiles which greet the eye of the traveller in France and Italy. The family is not confined to Europe, some of its members are found in each of the four quarters of the globe. It is to this group that the two species of English Lizard belong—*Lacerta agilis* and *Zootoca vivipara*. Between them a difference exists similar to that which has been mentioned in the two species of Snakes (p. 263). The larger Lizard (*L. agilis*) is oviparous; the smaller (*Z. vivipara*) brings forth her young alive: or, to speak more correctly, is ovoviviparous.*

Perhaps no one circumstance connected with their economy is more surprising, when seen for the first time, than the facility with which the tail separates from the body. Great is the astonishment of a person unacquainted with this peculiarity, when he grasps the tail and finds it remaining in his hand, while the swift-running reptile effects its escape.

The following characteristic occurrence is narrated by Dr. J. L. Drummond:—"Being on the sea shore at Pulo Bay, in Sardinia, and searching for specimens of natural history, I observed a large Lizard running for shelter under a heap of stones. I was just in time to seize it by the end of the tail; but suddenly the resistance made by the animal to my attempt to drag it from its hiding place ceased, and I gave it up for lost; but as suddenly had cause for alarm myself, on seeing what appeared to be a small Snake leaping with great agility about my feet, and springing as high as my knee. I instantly started out of its way, and watched it at a respectful distance, when I found that it was the tail of the animal, which I was not before aware could so easily separate." †

* The meaning of this term has been already explained, *vide* p. 263.

† "First Steps to Anatomy," p. 86.

As these animals come forth in sunny weather, decked in bright colours, and gifted with the power of rapid movement, it is not strange that, in more southern countries, where they are more numerous than here, they should be mentioned among the peculiarities and attractions of the scenery.

> ——————"The green hills
> Are clothed with early blossoms, through the grass
> The quick-eyed lizard rustles, and the bills
> Of summer-birds sing welcome as ye pass."
>
> CHILDE HAROLD, canto iv. st. cxvii.

From the most popular of the order, we turn to the most formidable, the Crocodiles. Of these, "the Alligators or Caymans are peculiar to America, the true Crocodiles to Africa, and the Gavials to Asia."* The Crocodile of the Nile formed one of the innumerable idols of the ancient Egyptians. His great strength is almost proverbial. "He esteemeth iron as straw, and brass as rotten wood. The arrow cannot make him flee; sling-stones are turned with him into stubble. Darts are counted as stubble; he laugheth at the shaking of a spear."† Yet this formidable reptile is endued with habits which render him one of the great benefactors of the human race.

"In the grand policy of nature, the scavengers are by no means the least important agents. In hot climates especially, where putrefaction advances with so much rapidity, were there not efficient and active officers continually employed in speedily removing all dead carcases and carrion, the air would be perpetually contaminated with pestilential effluvia, and entire regions rendered uninhabitable by the accumulation of putrefying flesh. Perhaps, however, no localities could be pointed out more obnoxious to such a frightful cause of pestilence than the banks of tropical rivers—those gigantic streams which, pouring their waters from realm to realm, daily roll down towards the sea the bloated remains of thousand of creatures which taint the atmosphere by their decomposition."‡

Such are precisely the situations inhabited by the various species of Crocodiles and Alligators. They are specially de-

* Berghaüs's Physical Atlas. By several naturalists the Crocodiles are formed into a distinct order, termed, from their peculiar covering, *Loricata*, or mailed.

† Job xli. 27-29.

‡ Jones's Outline, 559.

signed by nature to feed upon putrefying materials, and so strong is this impulse, that when they drown a living animal, it is said not to be devoured immediately, but dragged into some place where it can be kept until decay has set in.*

But though, like other gourmands, the Crocodile keeps his game until it has acquired the racy flavour and tenderness of muscle which come with decay, the organ of taste, the tongue, has not the usual freedom of motion; it is flat and fleshy, and is attached to the mouth so much that the ancients supposed it was altogether wanting.

We can account, therefore, for their idea respecting the tongue, but there were other notions current respecting the reptiles which cannot be so easily explained; such as their uttering piteous cries to allure travellers to the water, and there destroying them, weeping while they did so. To this tradition Shakspeare alludes in the passage—

> ——————— "Gloster's show
> Beguiles him, as the mournful Crocodile
> With sorrow snares relenting passengers."
> *Second Part* KING HENRY VI., Act iii. scene 1.

In the "Voiage and Travaile of Sir John Maundeville, Knt.," between the years 1322 and 1356, we are furnished with another example of the prevalence of these old errors:—

"In that contre and be all yonde, ben great plenty of Crokodilles, that is a manner of a long Serpent, as I have seyd before. These Serpents slew men, and thei eaten hem wepynge; and whan thei eaten, thei meven the over jowe, and nought the nether jowe: and thei have no tonge."

The Crocodile sometimes attains the length of thirty feet, but Mr. Swainson remarks, "that it is only dangerous when in the water; upon land it is a slow-paced and even timid animal, so that an active boy, armed with a small hatchet, might easily despatch one." He elsewhere adds, that on land, "so far from attacking man, they fly from his presence."

The beneficent provision by which the teeth are kept at all times in full order for their appointed functions, is not less complete or effectual than in the Shark (p. 226) or the Serpent (p. 261): a successive series of new teeth is ever growing throughout the entire period of life; each grows through the central portion of its predecessor, which is partly

* Swainson.

absorbed and finally thrown off. It was supposed by one writer that the Crocodile had so many teeth as there are days in the year. Professor Owen* remarks that the number of teeth developed by a Crocodile, throughout its entire life, would doubtless exceed even this liberal allowance. But with regard to those which are in use at any given time, the number is now well ascertained: the Crocodile of the Nile has sixty-eight; the common Alligator (*A. lucius*), seventy-six; and the great Gavial (*Gavialus Gangeticus*), one hundred and eighteen.

This notice of saurian reptiles, however slight, cannot be closed without some reference to the strange forms and gigantic proportions of the fossil species discovered in these countries.



Fig. 230.—Ichthyosaurus.

One of them, the *Ichthyosaurus* (*Fig.* 230), or Fish-lizard, received that name from some resemblance of the vertebræ to those of fishes. Seven or eight species are now known, exhibiting singular combinations of structure, such as are no longer found united in any living animal. Some of these individuals were not less than thirty feet in length. They were marine reptiles, preying upon fishes, whose scales and bones, found in hardened masses in the interior of the skeletons, and strewed elsewhere in great abundance, unfold a tale respecting the former inhabitants of the ancient ocean from which these islands were upheaved.



Fig. 231.—Plesiosaurus.

Another genus is that of the *Plesiosaurus*† (*Fig.* 231). "To the head of a Lizard is united the teeth of a Crocodile;

* Odontography, p. 286.

† From two Greek words, meaning "near to" and a "Lizard."

a neck of enormous length, resembling the body of a Serpent; a trunk and tail having the proportions of an ordinary quadruped; the ribs of a Chameleon, and the paddles of a Whale."*

The Plesiosauri appear to have lived in shallow seas and estuaries, and to have breathed air like the Ichthyosauri, or like the Whale and the Porpoise. The most remarkable character is the extraordinary extension of the neck, to a length nearly equalling that of the body and tail together, and surpassing, in the number of its vertebræ (thirty-three), that of the Swan. It is supposed to have "swum upon or near the surface, arching back its long neck like the Swan, and occasionally darting it down at the fish which happened to float within its reach."

The *Pterodactyles*† (*Fig.* 232) constitute another genus.

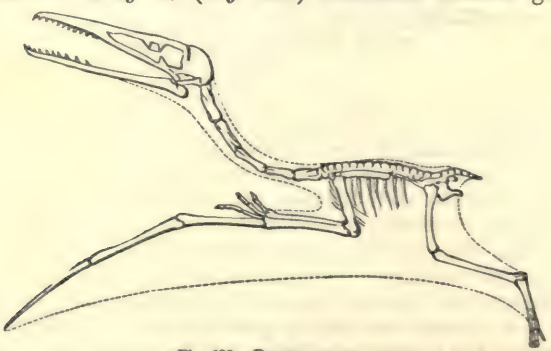


Fig. 232.—Pterodactyle.

About eight species are now known, the size varying from that of a Snipe to that of a Cormorant. They were considered by Cuvier the most extraordinary of all the extinct animals that had fallen under his observation; and such as, if we saw them restored to life, would appear most unlike to anything that exists in the present world.

These flying reptiles resembled, in some degree, our modern

* Dr. Buckland's Bridgewater Treatise. We use the words of that eloquent writer, so far as our limited space will permit.

† From two Greek words, signifying "wing-fingered," some of the finger-joints being of such a length as to have served as the supports for a membranous wing. The dotted lines in the figure (232) indicate the supposed outline of this wing, and of the skin of other parts of the body.

Bats. Most of them had the nose elongated, like the snout of a Crocodile, and the mouth armed with conical teeth. Fingers, furnished with long hooks, gave them the means of climbing trees, or hanging in the manner of the Bat and the Vampire. The eyes were of enormous size, apparently as a provision for nocturnal flight. From the remains of insects found with the bones of Pterodactyles near Oxford, some confirmation of the conjecture is derived, that their food was insects; but the larger species of Pterodactyle had head and teeth so much larger and stronger than such prey required, that they may possibly have fed on fishes, darting down upon them from the air. It is probable, therefore, they possessed the power of swimming; and thus qualified for all services and all elements, they realized Milton's description:—

——————"The fiend
O'er bog or steep, through straight, rough, dense, or rare,
With head, hands, wings, or feet, pursues his way,
And swims, or sinks, or wades, or creeps, or flies."
PARADISE LOST, Book ii. line 947.

ORDER IV.—TESTUDINATA.*—TORTOISES.

"And in his needy shop a Tortoise hung,
An Alligator stuffed, and other skins
Of ill-shaped fishes."—SHAKSPEARE.

LET it not excite surprise that, in the passage just quoted, the word "fishes" should be applied to reptiles. It is still used by the uneducated in speaking of warm-blooded mammalia, which, like the Whale, live in the sea. And let us not look with scorn upon those fallacies; for ever, as our own knowledge increases, we should become more sensible of its limited extent, and more indulgent towards the errors of others.

Tortoises are distinguished from all other reptiles by having

* Latin *Testudo*, a Tortoise. The Greek *chelys* signifies a Water Tortoise; the term *chelonian* reptiles, which is hence derived, is applied both to land and to water species.

the body enclosed between two shields, with apertures for the head, the tail, and the four legs. The jaws are horny and without teeth.

If we look upon one of the common Land Tortoises, slowly pacing along, and clad in its unyielding armour, we are inclined to ask, "Why should it be called a vertebrate animal? Where are the vertebræ and the ribs?"

If we examine the under side of the shield that covers the back of the animal (*Fig.* 233), the question may with ease be answered. The structure of that shield—or, as it is termed, the *carapace*—reveals the vertebræ and ribs, but

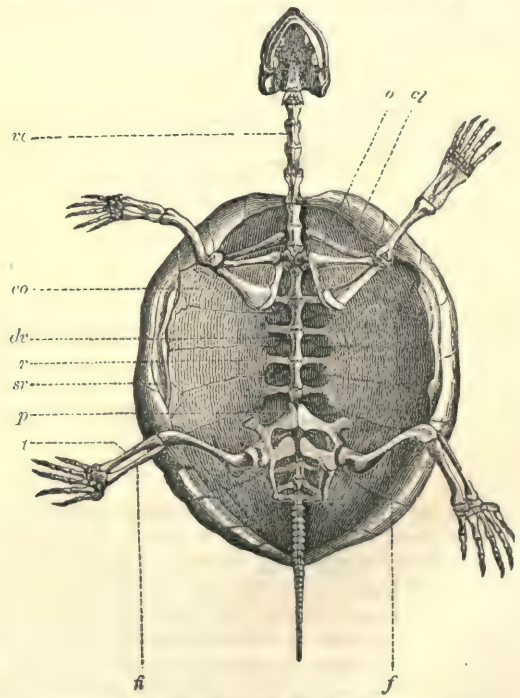


Fig. 233.—Skeleton of Tortoise.*

* Fig. 233.—Skeleton of Land Tortoise with the *plastron* or lower shell removed.—*vc*, cervical vertebræ; *dv*, dorsal vertebræ; *r*, ribs; *sr*, sternal ribs, or marginal pieces of the carapace; *o*, scapula; *cl*, clavicle; *co*, coracoid bone; *p*, pelvis; *f*, femur; *t*, tibia; *fi*, fibula.

strangely altered. The vertebræ have become immovable, and the ribs so widened as to touch each other throughout their entire length. Still the anatomist can trace, under these and other modifications of structure, the parts with which he is familiar in other animals. In the lower shell, or *plastron* (*Fig.* 236), he can, in like manner, recognize the breast-bone (*sternum*), modified in its structure, so as to form a large oval plate.

The number of species at present known is sixty-nine; and these, arranged according to their habits, may be conveniently spoken of as—

Land Tortoises, of which there are 15 species.
Freshwater Tortoises .....46 „
Turtles, or Marine Tortoises, ... 8 „

The animals of this order are, more than any other reptiles, limited to the warmer portions of the globe; yet three of the marine species, having at different times been borne by the waves and currents to different parts of the shores of these countries, are, according to established custom, entitled to rank with our indigenous animals.

Among the species thus added to our Fauna is the Hawk's-bill Turtle* (*Chelonia imbricata*, *Fig.* 234). The one best known to epicures is the Green Turtle (*Chelonia mydas*); but the former species is that which supplies the valuable Tortoise-shell of commerce, and to it our observations must be restricted.

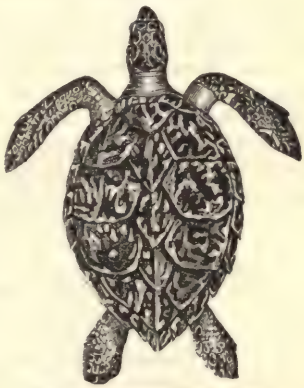


Fig 234.—Hawk's-bill Turtle.

"The structure of the whole family is admirably adapted to their marine habits. The body is flattened so as greatly to facilitate their progress through the water; the feet are formed into the most perfect oars, by means of which they are propelled

* The other two species are the Coriaceous Turtle—*Sphangis coriacea* and *Chelonia caouana*.

with considerable force and velocity."* "The Green and Hawk-billed in particular," says Audubon, "remind you, by their celerity, and the ease of their motions, of the progress of a bird in the air." They feed on sea-weeds, fishes, mollusca, and crustacea. The jaws are strong and firmly articulated; the horny beak, which bears some resemblance to the bill of a Hawk, is very hard, and the edge sharp.

The annual resort of the various species of marine Turtles to the land, for the purpose of depositing their eggs, is one of the most interesting points of their history. On the island of Ascension, on the shores of the Gulf of Florida, and in many other places, innumerable multitudes arrive for this purpose during the early part of the summer. The eggs, amounting to one hundred and fifty or two hundred, are laid in a hole scraped on the beach, they are then covered with sand; and the Turtle, having accomplished the object of her mission, retreats with all speed to the water.†

As the flesh of this species is not considered very palatable, the Tortoise is pursued and captured solely for the value of its shell. It is taken on the west coast of New Guinea, at Cuba, and at various other localities; but the Tortoise-shell which comes from the Pacific Ocean is considered much more valuable than that of the Atlantic.

The River Tortoises (*Trionycidæ*) are exclusively carnivorous, and eat their food in the water. They are without scales, and are hence called "soft Tortoises." In the Ganges they are very numerous, and prey like the Gavials on the bodies of the natives floating down the stream.‡ The feet are webbed. The Marsh Tortoises (*Emydæ*) are found about lakes, ponds, and small rivers, and swim with considerable

* Bell's British Reptiles, p. 2.

† The description given by the poet is too appropriate to be omitted:—

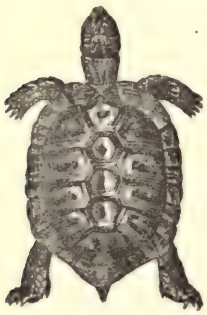
"The pregnant Turtle, stealing out at eve,
With anxious eye and trembling heart, explored
The loneliest coves, and in the loose warm sand
Deposited her eggs, which the sun hatched;
Hence the young brood, that never knew a parent,
Unburrowed, and by instinct sought the sea;
Nature herself, with her own gentle hand,
Dropping them, one by one, into the flood,
And laughing to behold their antic joy,
When launched in their maternal element."

‡ Swainson, p. 116. MONTGOMERY'S "PELICAN ISLAND"

facility. In them also the feet are webbed. The food consists of Fishes, Amphibia, Insects, Mollusca, and carrion. Some which inhabit the waters of Carolina and South America are called Alligator Tortoises, and are remarkable for their activity and for the great strength of their jaws.

The Land Tortoises (*Testudinidæ*) are entirely herbivorous; the feet are blunt, and furnished with short claws. The species best known in this country is the *Testudo Græca* (*Figs.* 235, 236). When at liberty, it buries itself towards

LAND TORTOISE.



235.—Upper Surface.



236.—Lower Surface.

the beginning of winter, and remains in its dormitory until spring.

The great longevity of these creatures seems to be one of the most remarkable circumstances in their history. One is recorded as living at Peterborough whose age must have been about 220 years. "Bishop Marsh's predecessor in the see of Peterborough had remembered it about sixty years, and could recognize no visible change. He was the seventh bishop who had worn the mitre during its sojourn there."* The weight of this animal was $13\frac{1}{2}$ lbs. yet it moved with apparent ease, though pressed by a weight of eighteen stone.

Mr. Darwin mentions the great abundance of Tortoises in all the Islands of the Galapagos Archipelago. These creatures sometimes grow to an immense size; he had been told of some so large that six or eight men were required to lift them from

* Extracted from Murray's "Experimental Researches," as quoted in a foot-note to Sir William Jardine's edition of "White's Selborne."

the ground. They are fond of water, travel great distances for it to springs on the elevated grounds, and drink large quantities. From this circumstance it occasionally happens that the inhabitants of the lower district, when overcome with thirst, will kill a Tortoise for the sake of the contained water. "They believe," says Mr. Darwin, "that these animals are absolutely deaf; certainly they do not hear a person walking close behind them. I was always amused, when overtaking one of these great monsters as it was quietly pacing along, to see how suddenly, the instant I passed, it would draw in its head and legs, and, uttering a deep hiss, fall to the ground with a heavy sound, as if struck dead. I frequently got on their backs, and then, upon giving a few raps on the hinder part of the shell, they would rise up and walk away; but I found it very difficult to keep my balance."*

Were we to give full credence to the authority of Pliny, we could not doubt, notwithstanding what has just been mentioned, that Tortoises have sadly dwindled from their former amplitude; for he expressly informs us, "there be found Tortoises in the Indian Sea, so great, that only one shele of them is sufficient for the roufe of a dwelling-house."† Exaggerated as this statement may appear, if applied to existing species, it is literally true respecting some which lived in remoter periods—another instance of how the light of Fiction "pales her ineffectual fire" before the brightness of Truth.

The fact to which we advert may be briefly told. In the north of India, and from the Sewalik Hills, which from a lower chain of the Himalaya Mountains, great numbers of the fossil remains of vertebrate animals were discovered by Dr. Falconer and Major Cautley. Among these were numerous fragments of a gigantic fossil Tortoise, which after their arrival in London were exhibited at a meeting of the Zoological Society,‡ and are now in the British Museum. From the relative size of the bones, and portions of the shell of this extinct reptile, as compared with the corresponding parts of recent species, it was estimated that the lower shell (*plastron*) had been nine feet four inches long, and the upper shell or buckler (*carapace*) twelve feet three inches; eight feet in

* Journal, p. 464. The species spoken of is the *Testudo Indicus*.

† Pliny's Natural History. London, 1634. Vol. ii. p. 431.

‡ Vide Proceedings, 26th March, and 14th May, 1844.

diameter, and six feet in height. The foot of the animal when living must have equalled in size that of the largest Rhinoceros. The entire length of the Tortoise, from the most careful admeasurement, was inferred to have been about eighteen feet, and its height more than seven.

These remains were collected during a period of eight or nine years, along a range of eighty miles of hilly country. From the circumstances under which they were met with, in crushed fragments, contained in elevated strata which have undergone considerable disturbance, no perfect "shell," nor anything approaching to a complete skeleton, was found. In 1835, when the first of these fossil remains were discovered, there was no record of any colossal reptiles of this order; and it became a question, "To what animal could these enormous bones have belonged?" Vain, for a long time, was all research and all conjecture; the problem was still unsolved, and the interest attached to its solution continued daily to increase. At length a small Land Tortoise furnished to the investigators the data for its solution. One of its diminutive leg bones resembled in form one of the immense fossils. And, as in the "Castle of Otranto" the helmet which filled the court-yard, the gigantic foot, the colossal hand, and the sword which required a hundred men to carry it, were all associated together; so, when the creature which had borne this ponderous fossil had been discovered, the mystery was revealed, and no difficulty was felt in assigning to every other bone its proper place.*

The researches of geologists have shown that several species of both Land and Freshwater Tortoises lived, in former times, in these countries; and the remains of the marine species discovered have been so numerous as to prove that our own seas were at one period more abundantly provided with Turtles, of different kinds, "than the same extent of ocean in any of the warmer parts of the earth at the present day."†

Having presented the Tortoise to our readers under so many

* The name bestowed on this fossil Tortoise was *Colossochelys Atlas:* the first term—literally, "Colossal Tortoise"—having reference to its size; the second to an Indian tradition, of the world having been placed on the back of an elephant, which was sustained on a huge tortoise; the creature thus performing the duty of Atlas, who, according to classic fable, supported the world on his shoulders.

† Professor Owen, in a paper read before the Geological Society, 1841

different aspects, we cannot conclude better than by exhibiting his behaviour when in love! The words are those of Professor Edward Forbes:—

"Among Lycian reptiles the Tortoise is the most conspicuous and abundant. The number of these animals straying about the plains, and browsing on the fresh herbage in spring, astonishes the traveller. In April they commence love-making. Before we were aware of the cause, we were often surprised, when wandering among ruins and waste places, at hearing a noise as if some invisible geologist was busily occupied close by, trimming his specimens. A search in the direction of the noise discovered the hammer in the shape of a gentleman tortoise, who, not being gifted with vocal powers, endeavoured to express the warmth of his affection to his lady-love by rattling his shell against her side."*

* Travels in Lycia, by Lieut. Spratt, R.N., and Professor Edward Forbes, vol. ii. p. 67. The species were *Testudo Græca* and *marginata*.

CLASS III.

AVES.—BIRDS.

"Birds, the free tenants of land, air, and ocean—
Their forms all symmetry, their motions grace."

JAMES MONTGOMERY.

WE have arrived at a new region, of a character altogether different from any that we have hitherto traversed. At other times, on crossing the line of boundary, we found the aspect of the country unchanged, and the inhabitants nearest to the frontier so like those from whom we had just parted, that at first sight they seemed members of the same fraternity. But such is not the case here; the cold-blooded reptiles can never be mistaken for the warm-blooded birds. We have reached a new land; we have come among a strange people. Let us observe their ways, and ask how they have been described by those who have made them an especial object of study.

Birds are oviparous animals; in other words, they are produced from eggs. They breathe by lungs, have warm blood, and a heart with four cavities—namely, two auricles and two ventricles. The body is covered with feathers, and is furnished with two wings and two feet.

Connected with this higher organization, we see in birds the power of flight in its fullest development. This alone would separate them from any other class of vertebrate animals. It is displayed in their long migrations, in the rapidity of their course, and in the force with which the Eagle, "towering in his pride of place," swoops upon his quarry.

This power of flight is, of itself, a singular and interesting subject, connected with the feathered tribes. It is one of those wonders which may be viewed every day, would we but open our eyes to see and our minds to consider them.

Let us, for a few moments, endeavour to divest ourselves of our familiarity with the phenomenon. "Let us," to use the words of the Bishop of Norwich,* "suppose a person to

* Familiar History of Birds, vol. i. Introduction, p. 3.

have grown from infancy to manhood, without ever having heard of a bird. He sees that the light snow-flake is unable to remain suspended in the air; that the still lighter thistle-down, when no longer supported by the breeze, has a tendency to fall to the ground; and yet he is told that there are tenants of the air, countless as those of earth and water; that some, of considerable size and weight, can journey on their way above the clouds, and with a facility and speed far exceeding that of the swiftest-footed animal. He may, indeed, from observing that cork and light bodies, when plunged in water, rise to the surface, conceive the possible existence of a lighter substance than air, capable, by the same laws of nature, of rising above the earth; if a philosopher, he may even discover the inflammable and lighter gas by which a balloon ascends, with the weight of a man attached; but how shall he lift a substance *heavier* than the air—and how guide its progress through the air? Show him the weighty body of an Eagle or a Swan;* tell him their living history, and he may reasonably doubt your fact, and deny that these things could be."

To understand the nature of the mechanism by which flight is effected, let us attend, in the first instance, to the structure of the skeleton of birds; and next, to the peculiarities connected with their respiration.

Skeleton.—The neck of birds is, in general, longer and more moveable than that of quadrupeds. As it is by means of the beak that their food is picked up from the earth, the neck, or *cervical* part of the vertebral column, is longer in proportion as the bird is more elevated by the length of its legs. In swimming birds, which, like the Swan, plunge their head into the water to take their prey, the length of the neck surpasses that of the trunk. The number of vertebræ differs much, according to the different species of birds. It is commonly twelve or fifteen; but in the Sparrow it is only nine, while in the Swan it reaches the extraordinary number of twenty-three. It is to this bountiful provision that this bird owes much of its grace and elegance: and this characteristic feature is therefore justly noticed by the poet:—

> ——————"The Swan, with arched neck
> Between her white wings, mantling proudly, rows
> Her state with oary feet."—PARADISE LOST, Book vii.

* The Wild Swan weighs about 25 lbs.

The joints of the neck are not only numerous, but are made to work on each other with great ease and freedom, and are furnished with numerous projections, to which the muscles are attached. Some of these are shown in the annexed figure (*Fig.* 237).



Fig. 237.—Skeleton of the Ostrich.

For the vertebræ of the back a different arrangement is required; strength, not flexibility, is the object; and, accordingly, in most birds they are united together, and are consequently immovable. They thus serve not merely as supports for the ribs, but have the solidity which is needful to furnish points of support for the wings also. So beautifully, however, are those structures modified, that in birds which do not fly, the consolidation of the joints of the back-bone does not take place, and some degree of movement is thereby secured.

This is exemplified in the Ostrich (*Figs.* 237, 249), and in the Cassowary (*Fig.* 238).



Fig. 238.—Cassowary.

Another peculiarity prevails in the birds just mentioned. The breast-bone (*sternum, Fig.* 239) never presents the projecting ridge, or keel, which we notice on the birds used as food in these countries. This keel serves an important office, as it increases the power of action in the muscles by which the wing is moved. It is large in proportion to the power of flight; but in birds which cannot possibly fly, and have only the rudiments of wings, the keel is altogether wanting.

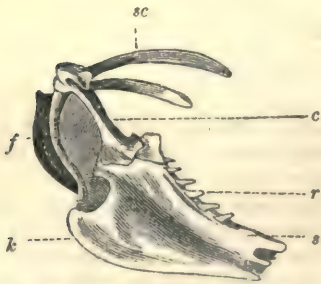


Fig. 239.—Sternum, or Breast-bone.*

* *s*, sternum; *sc*, scapula; *f*, clavicle; *k*, keel; *c*, coracoid; *r*, sternal ribs.

On each side of the well-known bone which is called the "merry-thought" (*furculum*), is one of a less symmetrical form, one extremity being thin and flat, while the other is spread out into a stronger and broader shape. If these bones be examined with reference to their uses in the framework of the bird, we find that the thinner side of the last mentioned is, in fact, one bone,* the broader side another bone,† constituting the great support of the shoulder; and that the "merry-thought" is composed of two joined together,‡ forming a figure like that of the letter V, the whole being so many buttresses to keep the shoulder joint firm and steady.

It may not be uninteresting to contrast the skeleton of the strich (*Fig.* 237) with that of the Vulture (*Fig.* 240), and to



Fig. 240.—Skeleton of the Vulture.§

observe the difference they exhibit in the bones of the wing, and several other particulars.

The bones of birds are not, however, remarkable only for their form or arrangement, but also for a peculiarity of struc-

* The Scapula. † The Coracoid. ‡ The Clavicles.

§ *vc*, cervical vertebræ; *vs*, sacral vertebræ; *vq*, caudal vertebræ; *st*, sternum; *cl*, clavicles; *h*, humerus; *o*, bones of the fore-arm; *ca*, carpus; *ph*, phalanges; *f*, femur; *t*, tibia; *ta*, tarsus.

ture by which great lightness is combined with strength, and the hollows of the bones in the adult birds are filled not with marrow, but with air. This remark is inapplicable to aquatic birds like the Penguin, which are unable to fly, but refers to those which, like the Eagle or the Swift, have the power of flight in its full development. In them, the bones, even to the extremities of the body, can, at the pleasure of the bird, be filled with air, the buoyancy of which is increased by the high temperature of the interior of the body. Thus we observe the opposite qualities of great strength and great lightness so admirably combined, that the greatest architects or engineers would here find their utmost skill surpassed, and learn how imperfect is human mechanism, compared with that evinced in the structure of every individual of those countless myriads by which the air is traversed.

Temperature.—The circulation of the blood in birds need not here be dwelt upon; its leading features are shown in the accompanying figure (*Fig.* 241); but it is worthy of remark, that the temperature of their bodies is, in some instances, several degrees higher than that of man. The blood heat of the human body is 98, and a thermometer held in the hand will not reach to within two or three degrees of that temperature; but, placed under the wings of different birds, it will rise to upwards of 100, and sometimes even to 110. This great amount of internal warmth gives to birds a power of enduring cold which, to our ideas seems incompatible with their habits. As an instance of this, we may mention that, on the bleak shores of Terra del Fuego, Humming-birds were seen during a snow-shower, hovering over the expanded blossoms of a Fuchsia.* What a strange sight! The Humming-birds and the snow—the representatives of the Tropic and the Arctic regions—united in the same picture.

Respiration.—The lungs of birds (*Fig.* 242) do not fill the cavity of the chest; they adhere to the ribs and have many openings through which tubes pass, conveying the air to the numerous air-cells distributed throughout the body. By means of this apparatus every part of the body can be inflated, the bones themselves rendered buoyant, and air propelled even into

* I owe the knowledge of this fact to the kindness of my valued friend, Captain Thomas Graves, R.N., H.M.S. *Volage*, who at the time was one of the officers in the expedition under command of Captain King, in whose "Voyages" it is also recorded.

the quills of the feathers. In the case of a wounded Heron, respiration was carried on for an entire day through a broken portion of the wing-bone.*

Covering.—Feathers, the peculiar and appropriate vesture of birds, present every variety of texture and of tint that the eye could desire, and far more than the imagination could

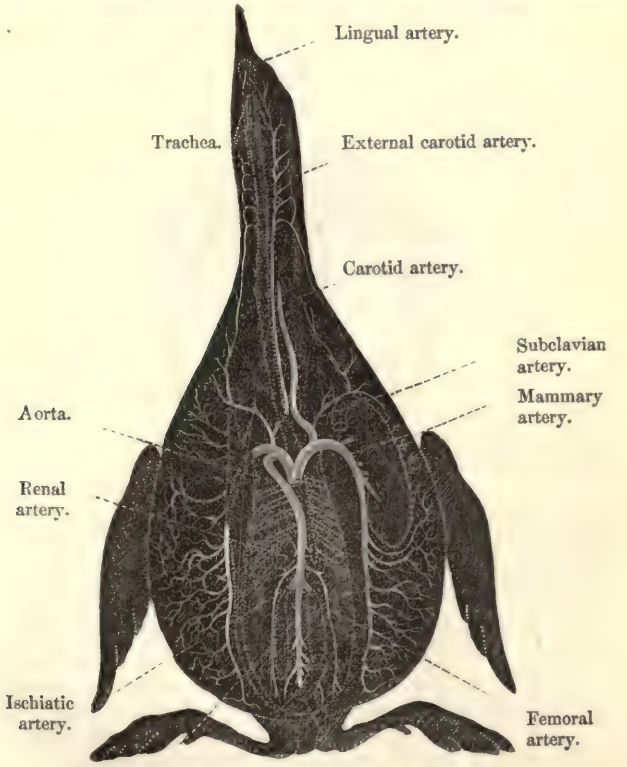


Fig. 241.—Arterial System of a Bird.

conceive. We see them in the Eagle compact and firm, in the Ostrich loose and curling, in the Penguin reduced to rudi-

* Linnæan Transactions, vol. xi. p. 11.

ments, resembling the scale-like covering of a fish, rather than that of a bird. The poet, in his description of their plumage, has in no way "o'erstepped the modesty of nature:"—

> "In plumage delicate and beautiful,
> Thick without burthen, close as fishes' scales,
> Or loose as full-blown poppies to the breeze;
> With wings that might have had a soul within them,
> They bore their owners by such sweet enchantment."
>
> MONTGOMERY'S "PELICAN ISLAND

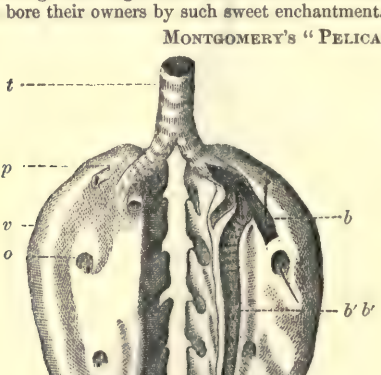


Fig. 242.—LUNGS OF A BIRD.*

By man, in a rude state of society, feathers were used for trimming his arrows, for decorating his person, and on all occasions of unusual ceremony and state. At present, they are no less valued. Wanting them, the most splendid pageants would lose much of their effect, and "the plumed troop" be shorn of a grace which no other part of its panoply could supply.

We must at present consider feathers rather in relation to the birds themselves than to the purposes of use or ornament to which they are applied by man. One obvious advantage to the birds is that of maintaining the warmth of their bodies, or that of their eggs at the time of incubation. All their uses, however, we can but faintly imagine; we know not in

* *t*, trachea; *p*, pulmonary vessels; *o*, one of the orifices of the bronchial tubes. The lung *v*, at the left hand side of the figure, is shown in its natural state; that on the other side is represented as partly laid open, so as to exhibit the bronchial tubes *b b'*, by which its substance is traversed.

how many ways their difference of structure and of colour may cause them to be acted on by the absorption or radiation of heat, the action of light, or of electricity. Viewed merely as a covering for the body, we find in aquatic birds a wise provision to convert them into efficient non-conductors of heat, by rendering them impervious to the water. Certain glands, situated near the tail, secrete an oily matter, which is spread by the bird over its feathers, and constantly renewed. By this means the plumage remains unwet, even in the water and the stratum of air between the body of the bird and the surface of the feathers being a bad conductor of heat, the vital warmth of the body is not dissipated. Limiting our consideration to another of their most obvious uses, let us view them as portions of the wings. The feathers of the wing are named according to the part from which they have their origin, and the bones are regarded as representing those of the fore-leg of quadrupeds, or the arm of man. Those feathers that grow on the part which corresponds to our hand are called the *primaries* (*Fig.* 243); those on what may be called the fore-arm the *secondaries;* and those on the part analogous to that between our elbow and our shoulder (*humerus*) are named the *tertiaries*.



Fig. 243.—Wing of Falcon.*

Every one has noticed the quickness with which the wings can be closed or expanded, and the compact space in which they are shut up when not in use; but, regarded merely as a piece of mechanism, their perfection is, perhaps, still better evidenced by the number of hours during which they can continue in active operation, without fatigue to the bird by whose exertions they are moved. The Swallow forms a good and familiar illustration of this remark. During the time this bird is employed in building its nest, or catering for its young, its activity is ceaseless, and is interrupted only by the brief intervals of rest attendant on the delivery of the material or of the food.

Perhaps the most striking illustration of long-sustained powers of flight is afforded by the Frigate or Man-of-war-

* *p*, primaries; *s*, secondaries; *t*, tertiaries.

bird (*Fig.* 244), which abounds both in the Atlantic and Pacific Oceans. The extent of wing is, probably nine or ten feet, though twelve, and even fourteen feet have been stated. With these ample pinions it fearlessly wings its way over the



Fig. 244.—Frigate-Bird.

ocean, and is frequently found leading a life of ceaseless rapine at a distance of more than a thousand miles from the nearest shore. Its support is derived exclusively from the sea, yet it is never known to rest upon its surface. "Supported in its unlimited flights by the strength and expansion of its wings, and aided by the singular mechanism of its tail, and the buoyant nature of the inflated sac which distends its throat, it seems to be an inhabitant of the air rather than of the land, where it resorts alone for the duties of its nest, or of the water, over which it only hovers for its prey."*

When navigators give us detailed accounts of the habits of a bird which even the naturalist describes as an inhabitant of the air rather than of the land or of the water, it is not surprising that the idea was at one time current, that in the sunny islands of the East there were birds whose lives were passed upon the wing, and to whom, as they never perched, feet would have been unnecessary appendages. We allude, of course, to the Birds of Paradise, more fully noticed hereafter.

* Vigors in Linn. Trans., vol. xiv. p. 419.

The elaborate provision made for the buoyancy of birds is so remarkable a characteristic of their structure, that we shall bring forward another example of its perfection in the Gannet or Solan Goose (*Sula bassana, Fig.* 245), of our own shores.

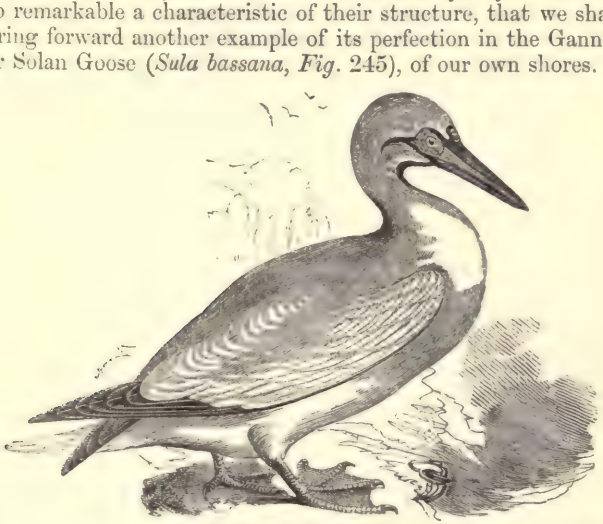


Fig. 245.—Gannet.

This bird is very abundant in Norway and in the Hebrides; and, farther south, the Craig of Ailsa, the island of St. Kilda, and the Bass Rock in the Firth of Forth, are favourite breeding-places. So great are their numbers that the inhabitants of St. Kilda, according to Martin, consume annually 22.000 young birds of this species as food, besides an immense quantity of the eggs.* In more remote localities, the birds are not less numerous.

The Gannet, when searching for food, flies a short way above the suface of the water, and, on seeing a fish, rises into the air, and descends with such rapidity and force as to secure its prey. Some idea of the power of its descent may be formed from a circumstance related by Pennant. One of these birds, flying over Penzance, saw some pilchards spread out upon a

* Buchanan, in his View of the Fishery of Great Britain, conjectures that the Gannets of St. Kilda destroy, annually, one hundred and five millions of herrings. In Sir Walter Scott's "Antiquary," this bird is mentioned as "the relishing Solan Goose, whose smell is so powerful that he is never cooked within doors." The figure of this bird (*Fig.* 245), and that of the Diver (*Fig.* 281), are copied from Yarrell.

fir plank about an inch and a-half thick, and which was used in the curing of the fish, and darted down with such violence that it struck its bill quite through the board, and broke its neck. Pennant adds, that these birds are sometimes taken at sea by a similar deception, a fish being fastened for the purpose to a floating plank.

But perhaps a juster estimate of the impetus of the descent may be formed from the depth to which it propels the bird in the water. Respecting this we possess the means of accurate information; for Gannets are not unfrequently found entangled in fishing-nets, and the depth at which these nets are fixed is ascertained. Thus, at Ballintrae, on the west coast of Scotland, and not remote from the Craig of Ailsa (which has been mentioned as one of their haunts), the Gannets are not unfrequently taken in nets sunk to the depth of from nine to twenty fathoms, and sometimes to that of thirty fathoms.* On one occasion, so many as 128 of these birds were thus captured at one time, and in their struggles brought the nets with their sinkers and fish to the surface.

The Gannet swims high in the water, buoyant as the foam which crests the wave on which it rides. Its flight and its swimming evince its extreme lightness; its force of descent no less establishes its possession of a certain degree of density. How are these opposite qualities united in the same individual? On this point we are not left to conjectures, but can appeal to facts which anatomists have made known from a careful examination of its structure. Thus, a Gannet which died in the Zoological Gardens of London was examined by Professor Owen,† chiefly with reference to the air-cells, which, in this bird, as in the Pelican, have a most extensive distribution. By means of a gentle but continued inflation through the windpipe, the integuments of the whole of the lateral and inferior parts of the body rose, and the air-cells seemed completely filled, especially that which is situated in front of the merrythought. Further investigation showed that a free communication existed among these, with the exception of that in front of the breast. This cell was found to be of a globular form, about four inches in diameter, and communicating directly with the lungs themselves. Numerous strips of muscular fibre

* A fathom is six feet. The facts are recorded by Mr. Wm. Thompson, Magazine of Natural History, vol. ii. No. 13.

† Proceedings of Zoological Society, 1831.

passed from various parts of the surface of the body, and were attached to the skin; and a beautiful fan-shaped muscle was also spread over the anterior surface of the large air-cell just mentioned. "The use of these muscles appeared to be to produce instantaneous expulsion of the air from these external cells, and by thus increasing the specific gravity of the bird, to enable it to descend with the rapidity necessary to the capture of a living prey, while swimming near the surface of the water."

This is one of those beautiful adaptations of means to an end which Natural History records in every department. "The descent of the Gannet on its prey has been, not inaptly, compared to that of an arrow, the beak of the bird forming the arrow head, and the body and wings the feathered shaft of the weapon—we here have the secret of its heavy fall; the same machinery restores the buoyancy at the proper moment, and the bird rises with its fish aloft."

Moulting.—The plumage of birds is periodically renewed, and the process of this change of feathers is termed "moulting." The aspect of the bird, in many instances, changes, not only with age, but also with the season; the summer dress, as we shall have occasion to mention, is often very unlike that of the winter. The changes in the plumage of birds have been investigated with great care by Mr. Yarrell; and, in the opinion of that able zoologist, the different appearance which it presents may be explained,—

1st. By the feather itself becoming altered in colour;

2nd. By the birds obtaining a certain addition of new feathers, without shedding any of the old ones;

3rd. By an entire or partial moulting, at which old feathers are thrown off, and new ones produced in their places; and,

4th. By the wearing off of the lengthened lighter-coloured tips of the barbs of the feathers on the body, by which the brighter tints of the plumage underneath are exposed.

In spring, the change which takes place prior to the pairing season is to be attributed to the first two modes; and at that time, also, there is a partial moulting of old feathers—a laying aside, as it were, of a portion of the warm garments of winter. The entire moulting is that absolute change of feathers which takes place in autumn.

Digestive Organs.—If, quitting for a moment the consideration of the feathered tribes, we cast our eyes on those of the next and highest division of vertebrated animals, we find the mammalia subsisting on a great variety of food—on grasses, grain, fruit, seeds, and herbage—on insects, worms, and mollusca—on the flesh of various reptiles, fishes, birds, and on that of animals of their own class; and, if we examine the structure of their mouths, we find that they are furnished with teeth so especially adapted for the several varieties of food, that the habits of the animal can with certainty be predicted from a glance at these efficient organs. Had we never seen a bird, and were required to describe the structure necessary to enable a race of feathered, two-legged animals to subsist on the like variety of food, we would probably consider a supply of teeth, resembling those of the mammalia, but less in size, as the very first requisite. These teeth would require to be fixed in jaws of corresponding strength and weight, and these jaws to be worked by muscles of sufficient power—an arrangement inconsistent with the lightness which is absolutely essential. This problem we have supposed has already received its solution. The organs we would have thought most needful are altogether omitted, and their functions are performed by an apparatus so unlike in structure, and yet so efficient in its working, that it declares, on the part of its Artificer, an amount of skill, of knowledge, and of power alike unlimited.

The bill, being the instrument by which food is taken, first demands our examination. It is, externally, of a horny texture, and exhibits great variety in its form, and no less in the uses to which it is subservient. In some tribes, it is simply an organ for prehension, used in picking up grains or worms. In others, it is employed to separate the seeds from the husks. In the Ibis (*Fig.* 278), it is long and bent downwards; in the Avocet (*Fig.* 246), it is long, and curved upwards; in the Snipe it is a probe; in the Swallow, a fly-trap; in the Duck, a shovel, and at the same time a strainer; by the parrot it is used as a help in climbing; by the Vulture (*Fig.* 255) as a carving knife for his gory feast.

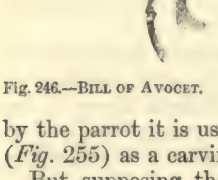


Fig. 246.—Bill of Avocet.

But, supposing the food to be procured, it is needful, in

the next place, that there should be some convenient receptacle into which it can be instantaneously transferred, until wanted. In some birds, which, like the Swift, live upon insect prey, seized when on the wing, the upper part of the throat is so large as to answer for this purpose. In the Pelican, a peculiar pouch is attached to the lower jaw (*Fig.* 247), and in this a goodly store of fish can be carried about. In the Cormorant, the gullet itself is dilated, so that it is not unusual, when the bird has got a fish too large to be swallowed at once, to see the tail hanging for a time out of its mouth. But the plan which is most usual, is that which may be exemplified in the

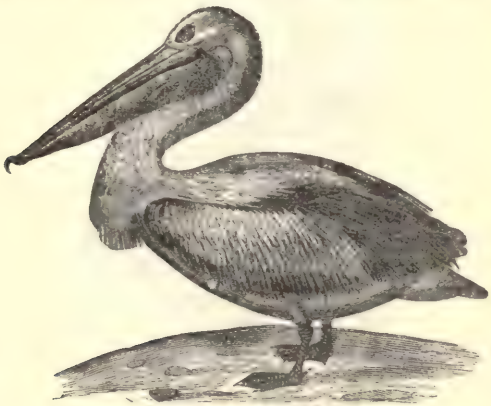


Fig. 247.—Pelican.

digestive system of a common fowl (*Fig.* 248). The gullet, (*œsophagus*) is suddenly expanded, forming a bag or chamber, known as a crop. Beneath this there is a slighter expansion, which forms the second or membranous stomach, in which the food is softened by the action of what is called the gastric juice. From this the food passes on to the third stomach, in which the process of digestion is completed. In flesh-eating birds, this stomach is thin and membranous; but in those which feed on grain, the sides of it are of considerable thickness, and, being moved by powerful muscles, act as a mill in grinding down the food. Many who see the gizzard of a fowl at table know that it serves in the economy of the bird as a grinding machine; but comparatively

few know that the gizzard is actually the stomach itself, which, thickened in its coats, performs the same office as the teeth of the graminivorous quadrupeds.

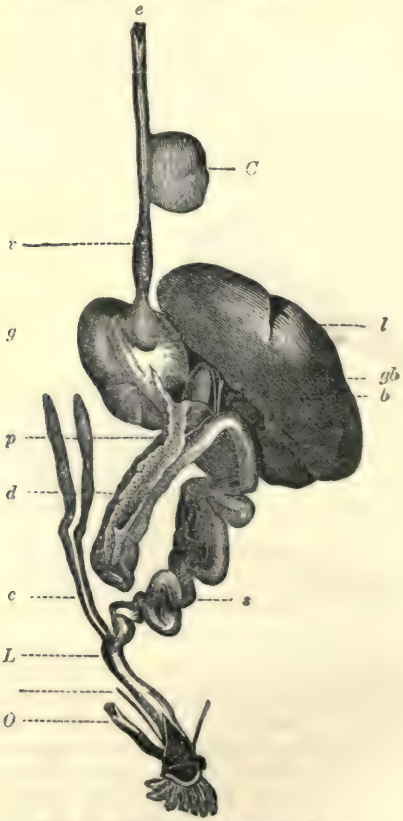


Fig. 248.—Digestive Apparatus of a Fowl.*

The action of the gizzard is expedited by small pebbles and other hard substances swallowed by the fowl. In the Ostrich (*Fig.* 249), this instinctive action prevails to such an

* *e*, œsophagus; *C*, crop; *v*, ventriculus succenturiatus; *g*, gizzard; *l*, liver; *gb*, gall-bladder; *b*, bile-ducts; *p*, pancreas; *d*, duodenum; *c*, cœca; *s*, small intestine; *L*, large intestine; *O*, oviduct.

extent, that in the stomach of one were found pebbles sufficient to fill a large glass bottle; and as the Ostrich will swallow metals with equal readiness, popular credulity, in former times, went so far as to assign to it the power of digesting these substances; and many are the allusions in the older writers to this supposed power of "the iron-eating Ostrich."*



Fig. 249.—African Ostrich.

Senses.—The two senses which appear to be developed in the highest degree in birds are those of sight and of smell. The arrangements connected with the eye, regarded as an optical instrument, are, in all their details, replete with evidence of design. It has to perform a variety of functions, and demands a corresponding variety in the adjustment of its several parts. It must be fitted for vision at the altitudes to which birds of prey soar, and equally fitted for vision near at

* Mr. Bennett, in "Gardens and Menageries," quotes the following lines, as illustrative of the prevalence of the belief. The author is Skelton, a laurelled poet of the reign of Henry the Eighth:—

"The Estridge that will eate
An horsehowe[1] so greate,
In the steade of meat;
Such fervent heat
His stomake doth freat."

[1] Horse-shoe.

hand. It must be adapted for rays of light passing through media of very different densities, and of different degrees of transparency. Conditions have, therefore, to be fulfilled with regard to the eye of birds, which are not required in the best optical instrument of human construction; and, at the same time, it is needful that the focal distance, fitted for near or for distant vision, should be adjusted with a rapidity very different from the "rack and pinion" adjustments of our most skilful opticians. Details connected with this subject would here be out of place, and must be sought for in works of a less elementary character.*

One obvious peculiarity may, however, be mentioned: birds possess, not *two*, but *three* eyelids. The third, termed the *nictitating membrane*, lies in the inner angle of the eye when not in use. By the action of powerful muscles, it can in a moment be swept over the surface of the eye, and then by its own elasticity spring back to its former place. It is membranous, and somewhat transparent; and some authors who describe the Eagle as gazing on the sun, assert that he does so by means of the protection which this membrane affords.†

Smell.—The sense of smell in birds has been subjected to various experiments, to ascertain the extent to which it exists; and the development of the olfactory nerves in more than one species has been examined by Professor Owen.‡ A Vulture, which formed the subject of one of his investigations, was the Turkey Buzzard (*Vultur aura*), a bird extremely abundant in Jamaica, where it is known by the familiar name of "John Crow." It feeds on carrion, and its services are considered so valuable, that the killing of one within a certain distance of the principal towns is an offence punishable by fine. The notes of Professor Owen prove the existence in this Vulture of a well-developed organ of smell. The same fact is established by the observations of Mr. Sells. It is to be recollected that, in hot climates, the burial of the dead commonly takes place in about twenty-four hours after death, on account of the rapidity with which decomposition takes place. "On one

* Jones's "Outline," p. 609. Yarrell's "Birds," 1st edition, vol. i. p. 11, 14, and 138.

† The poet thus refers to the popular belief:—

"Nay, if thou be the princely Eagle's bird,
Show thy descent by gazing 'gainst the sun."

KING HENRY VI., Part iii. Act ii. scene 1.

‡ Proceedings of Zoological Society, March, 1837.

occasion," says he, "I had to make a *post-mortem* examination of a body within twenty-four hours after death, in a mill-house completely concealed; and while so engaged, the roof of the mill-house was thickly studded with these birds"* (the Turkey Buzzards). On another, "the family had to send for necessaries for the funeral to Spanish Town, distant thirty miles, so that the interment could not take place until noon of the second day, or thirty-six hours after his decease; long before which time—and a most painful sight it was—the ridge of the shingled roof of his house, a large mansion of but one floor, had a number of these melancholy-looking heralds of death perched thereon, besides many more which had settled in the vicinity. In these cases, the birds must have been directed by smell alone, as sight was totally out of the question."†

The obtuseness of the sense of smell, in another species, seems to be no less clearly established. Mr. Darwin saw, at Valparaiso, between twenty and thirty Condors, which were kept in a garden there, and fed once each week. The Condors were tied, each by a rope, in a long row at the bottom of a wall; he was thus enabled to try the following experiment:—having folded up a piece of meat in white paper, he walked backwards and forwards, carrying it in his hand, at the distance of about three yards; but no notice whatever was taken. He then threw it on the ground, within one yard of an old cock bird, which looked at it for a moment with attention, but then regarded it no more. Mr. Darwin pushed it closer and closer with a stick, until the Condor touched it with his beak; the paper was then instantly torn off with fury, and, at the same moment, every bird in the long row began struggling and flapping its wings.‡

The controversy between some authors, as to whether Vultures are guided to the carrion on which they feed by the sense of sight or that of smell, is like the combat of the two knights, as to whether the statue bore a shield of gold or of silver. It was composed of both. And, in like manner, there seems no good reason for doubting that both senses are made

* Penny Cyclopædia, article Turkey Buzzard.

† Zoological Proceedings, March, 1837. The same evening on which Professor Owen's communication on the development of the olfactory nerves was read.

‡ Journal, p. 222. Voyage of the Adventure and Beagle.

to contribute to the welfare of the birds, by directing them to their prey. The far-sighted eye sees it from the clouds, and the characteristic flight of the Vulture, as it descends to the feast, reveals to its brethren the fact that a repast is spread for them; and from all quarters they hasten to participate. And, again, when near at hand, under the screen of cliffs, or the thick-tangled vegetation of tropical forests, the sense of smell reveals the hidden carcase, and tempts around it those who act an important part as agents for its removal. Different species may be supposed to possess these powers in varying degrees of perfection, so that each may most efficiently perform its allotted duty.



Fig. 250.—Pouched Adjutant.

The Vultures are not the only birds by which the removal of decaying animal matter is carried on; it is shared by those belonging to other orders. Thus, in India, there is another whose services are no less valuable, and whose appearance is altogether different. It is a gigantic Crane, called the Adjutant (*Fig.* 250). This bird, and a species found in Senegal, furnish the valuable marabou feathers. It is called the Pouched Adjutant, from a bag or pouch on the middle of the neck, and which pouch has been likened by Cuvier to "a large sausage." Its utility as a scavenger is so great, that the bird is not only permitted to remain unmolested, but is held in great estimation, and, from superstitious feelings, even regarded with reverence. It is a voracious feeder, and gulps down its food whole. It has been known to swallow a leg of mutton, five or six pounds weight; and Sir Everard Home states, that in the stomach of one a Land Tortoise ten inches long, and a large black Cat, were found entire.

Removal of Decaying Animal Matter.—We would wish here to call attention to the provision so abundantly made for

the removal of putrefying substances, which would soon taint the atmosphere, and spread disease and death around. Many birds, besides those we have named, share in this labour, converting into nourishment that which would otherwise prove baneful. Among the mammiferous animals, we find some that prey upon the helpless and the dead; and thus the carnivorous tribes, both of birds and quadrupeds, carry into effect the same beneficent provision. But they are not the sole, though they are the most powerful, workers; there are others, both on land and water, whose diminutive size is more than compensated by their countless numbers. Let us revert to some of the invertebrate animals, whose habits have been briefly noticed, and see how numerous are these labourers, how different their structure, yet how effectually they all work together. Even in the brief space to which we have been restricted, we have enumerated, as devourers of organized matter in a state of decay, Infusoria, Star-fishes, Earth-worms, Crustacea, Insects, Mollusca, Fishes, Crocodiles, and we now add Birds and Mammals. Each individual acts for himself alone; yet all unconsciously co-operate in carrying out one harmonious design. Without the ceaseless efforts of these heterogeneous labourers, the air, the rivers, and the seas would alike become loaded with impurities, and the earth would soon be converted into one great charnel-house. The wisdom by which a comprehensive scheme for preventing this result has been formed, and the providence by which it has been sustained, speak alike of HIM by whom these animated tribes have been called into existence, and have been gifted with their several capacities.

Migration.—At the approach of winter, there are various birds which make their appearance pretty nearly at the same time each year, and leave us early in the spring. They have arrived from regions farther north, and have made our islands the *southern* limit of that periodical change of residence to which we give the term "migration." There are others whose appearance in spring we welcome, not only because of the beauty of their flight or their plumage, or the cheerfulness of their notes, but because we know from experience that these feathered visitants are the harbingers of brighter skies and renovated verdure. These lovely heralds of the spring stay with us during the summer, and then wing their way to the south. The British Islands constitute the *northern* limit of

their migration. It is now ascertained, that the greater number of these summer birds leave these kingdoms for the north and west of Africa,* whence they return annually, with such punctuality, that their appearance is looked for with confidence within a day or two of the particular time.

These few simple facts are nearly all that we can be said to know with certainty on the mysterious subject of migration. It has been asserted that birds change their quarters because of inclement seasons, scarcity of food, and other evils, which are avoided by their change of residence. But if these supposed explanations be scrutinized, they will be found unsatisfactory. The truest philosophy is candidly to avow our ignorance of the subject, and to regard birds as acting under an impulse implanted in their constitution by the Creator. Observation only corroborates, that "the Stork in the heavens knoweth her appointed times, and the Turtle, and the Crane, and the Swallow observe the time of their coming."†

Several observers have stated, that migratory birds, when in confinement, though plentifully supplied with food, show evident symptoms of restlessness when the period arrives at which their fellows take their departure. So powerful is this migratory instinct, that birds will forsake their young and leave them to perish, rather than not accompany their companions. This proceeding, so contrary to all that we see of the devoted attachment of the parent birds to their offspring, was first observed by Mr. Blackwall, who states‡ that, in the spring of 1821, a pair of House-martins, after taking possession of a nest which had been constructed in the preceding summer, drew out the dried bodies of three nearly full-fledged nestlings which had perished in it. About the same time, another pair of House-martins, being unable to dislodge the young, closed up the aperture with clay. This suggested

* Several British species were observed, on their migration northward, by Mr. W. Thompson, when on his passage from Malta to the Morea, in H.M.S. Beacon, in April, 1841. Annals Nat. Hist., vol. viii. p. 125.

† The lines of Pope are highly descriptive and appropriate:—

"Who bid the Stork, Columbus-like, explore
Heavens not his own, and worlds unknown before?
Who calls the council, states the certain day,
Who forms the phalanx, and who points the way?
God in the nature of each being sounds
Its proper bliss, and sets the proper bounds."

‡ In his Researches in Zoology.

examination in future years, after the Martins and Swallows had taken their departure; and, each time, several nests were found containing dead nestlings which had been abandoned by the parents. Upon these interesting facts Mr. Thompson remarks:—"In the instances above alluded to, the young broods and eggs were deserted late in the season, and I should suppose at the migratory period. The paramount object would then seem to be migration; and, when favourable weather and wind prevail, the love of offspring yields to the stronger impulse, and the parents take their departure. Had this favourable time been long enough protracted, they would have continued to tend their offspring, and bring them to maturity."*

Affection for their Young.—The instances just mentioned are the exceptions to that ardent attachment to their young which birds evince. If danger threaten, the most timid becomes bold, and is ready to give battle to the assailant.† In the cold-blooded vertebrate animals, the mother, in most cases, is satisfied with depositing the spawn in a suitable situation, or the eggs in what seems a place of security. With this her care for the future progeny is ended, and she experiences nothing of the actual cares or pleasures of maternity. But the proceedings of birds, prior to the exclusion of the young from the egg, and afterwards in regard to the attention bestowed upon them, is in every respect so sedulous, so unceasing, and so replete with tenderness, that it is not in the power of language to convey a picture of affectionate solicitude beyond that which is employed in reference to their ordinary habits.‡ The exertions made by the parent birds to procure for their helpless young the supply of the requisite food, are so unceasing, and are carried on with such entire forgetfulness of self, as to excite the admiration even of the most incurious. When, therefore, the poet recounts the simple facts which

* Annals of Natural History, vol. ix. p. 378.

† ——————"The poor Wren,
The most diminutive of birds, will fight,
Her young ones in the nest, against the Owl."
SHAKSPEARE.

‡ The reader will recall to mind, as an example of this, the memorable words—"O Jerusalem, Jerusalem! which killest the prophets, and stonest them that are sent unto thee: how often would I have gathered thy children together, *as a hen doth gather her brood under her wings*, and ye would not!"—LUKE xiii. 34.

observation reveals, he wakens into activity some of our purest sympathies; nor can the naturalist present a picture more faithful than that which is arrayed in the garb of verse: the truth and the poetry are one.

"Some sought their food among the finny shoals,
Swift darting from the clouds, emerging soon
With slender captives glittering in their beaks;
These in recesses of steep crags constructed
Their eyries inaccessible, and trained
Their hardy brood to forage in all weathers.
Others, more gorgeously apparelled, dwelt
Among the woods, on Nature's dainties feeding—
Herbs, seeds, or roots; or, ever on the wing,
Pursuing insects through the boundless air;
In hollow trees or thickets these concealed
Their exquisitely woven nests, where lay
Their callow offspring, quiet as the down
On their own breasts, till from her search the dam
With laden bill returned, and shared the meal
Among her clamorous supplicants all agape;
Then, cowering o'er them with expanded wings,
She felt how sweet it is to be a mother."

MONTGOMERY'S "PELICAN ISLAND."

Nests.—We turn from the young birds to those singular habitations in which they are hatched. The smallest amount of observation makes manifest to every one, the great diversity of their situation, structure, and materials. As examples, we may mention the exposed nest of the Sky-lark, built upon the ground, compared with the globular edifice of the Wren, constructed in sheltered situations, and ingeniously concealed from view; or the neat and elaborately



Fig. 251.—NEST OF GOLDFINCH.

finished nest of the Goldfinch (*Fig.* 251) contrasted with the coarser edifice of the Rook or the Magpie.

But, regarded merely as a work of art, some of the nests from foreign countries appear more ingenious and more artistical, though, of course not better adapted to the wants of their respective occupants. Thus the nests of the Baya, a bird of Hindostan, are formed of long grass woven together in the shape of a bottle (*Fig.* 252), and suspended "to the extremity of a flexible branch, the more effectually to secure the eggs and young brood from serpents, monkeys, squirrels, and birds of prey. These nests contain several apartments, appropriated to different purposes."* The entrance is at the lower part, so that the parent birds reach it only when on the wing.

Another species, called, with great justice the Tailor-bird (*Sylvia sutoria*), collects from the cotton-plant fibres of cotton,



Fig. 252.—Nest of the Baya.



Fig. 253.—Nest of the Tailor-Bird.

and with them sews two leaves together, the bill being used as a needle. The nest is concealed in the space between the two leaves (*Fig.* 253).

* Forbes's Oriental Memoirs, vol. i. p. 48.

In the former part we mentioned (p. 137), that some Caterpillars spin a snow-white canopy, and dwell together in social communities. Among birds we have an example of their united efforts being, in like manner, employed in the construction of a common covering. This is observable in the Sociable Grosbeak (*Loxia socia*), a species found about the Cape of Good Hope. These birds construct a roof of grass matted together; and beneath the eaves of the shed thus formed by their joint labour, the individual nests are built (*Fig.* 254). Some idea of the size and solidity of these structures may be formed from the fact mentioned by Vaillant,* that having observed one of enormous size, he despatched some men with a waggon to bring it, and on its arrival he cut it to pieces with a hatchet.



Fig. 254.—Nest of Sociable Grosbeak.

Organs of Voice.—The period when birds are about building their nests, and engaged in attending to the callow young, is that in which our groves become "prodigal of harmony." This may, therefore, be a fitting place to make some remarks on the organs of voice. In birds they consist of a wind-pipe, which divides at the lower part into the two branches called the bronchial tubes—one leading to each lung (as shown in

* Travels, second series, vol. iii.

Fig. 242). At the upper part of the wind-pipe is an organ (the *glottis*, or superior larynx) by which the size of the aperture seems to be regulated. At the lower part is placed the true organ of voice in birds (the inferior larynx); and, in all those which possess the vocal powers in the highest perfection, this part is furnished with five pair of nerves. "The tube of the wind-pipe," says Mr. Yarrell, "is composed of two membranes, enclosing between them numerous cartilaginous or bony rings, forming a cylinder more or less perfect from end to end."* The tube differs in its length, its diameter, and its substance, in different species; and in some it exhibits convolutions which modify its powers. "The principle upon which the organs of voice in birds is founded, is that which prevails in wind instruments generally; the notes in the ascending scale being produced by a corresponding contraction of the diameter or the length of the tube, and *vice versâ*."

Such is the description given by physiologists of the mechanism which produces the loud note of the Wild Swan, the booming of the Bittern, the cawing of the Rook, the hooting of the Owl, and the wild screams which, heard amid the native haunts of the sea-fowl, harmonize with the surging sea. Birds, as we all know, can be taught to imitate the tones of the human voice; nor is this limited to the Parrot; the power is enjoyed, among our native birds, by the Raven, the Magpie, the Jay, and the Starling. So distinctly have Ravens been taught to articulate short sentences, that one living at Chatham, "in the vicinity of the guard-house, has more than once turned out the guard, who thought they were called by the sentinel on duty."†

The power of imitation reaches, perhaps, its highest perfection in the Mocking-bird of America. So perfect is his performance, that not only the experienced ear of the fowler is deceived, but even birds themselves are imposed upon. In a domesticated state he finds equal scope for the versatility of his powers, and his doings have been most graphically recorded by Wilson, in his American Ornithology:—"He whistles for the dog; Cæsar starts up, wags his tail, and runs to meet his master. He squeaks out like a hurt chicken, and the hen hurries about, with hanging wings and bristled feathers, clucking to protect its injured brood. The barking of the dog, the

* British Birds, vol. ii. p. 71.

† Quoted by Mr. Yarrell, from Swainson and Richardson.

mewing of the cat, the creaking of a passing wheelbarrow, follow with great truth and rapidity."

Distribution.—To one who regarded only the powers of flight which birds possess, it might seem easy for beings so endowed to change their abode at pleasure, and not, like the more slow-moving mammalia, be restricted to certain regions; but here, as in every other department of Zoology, the laws of geographical distribution are more potent than the mandate of the king who placed his chair upon the beach, and forbade the approach of the waves—"Thus far shalt thou come, and no further."

The number of species is supposed to be about four times greater than that of quadrupeds; and, with the exception of fishes, they are more widely distributed than any other class of vertebrated animals. Mammalia and reptiles are, to a great extent, limited to the warmer regions; but birds are found in every part of the earth, from the equator to the poles.

The number of species is greatest towards the equator, except among the aquatic tribes. Europe is regarded as remarkably rich in the number of its birds, the species amounting, according to a catalogue* published in 1840,† to 490, arranged in thirty-four families, and one hundred and sixty-four genera. It is interesting to observe the comparative numbers belonging to the leading groups:—

Rapacious Birds	54 species.
Perching and Climbing Birds	209 „
Scraping Birds	28 „
Wading Birds	87 „
Swimming Birds	112 „
TOTAL	490 species.

Classification.—The number of species at present known to naturalists is in some degree doubtful, for the same bird has frequently appeared under more than one name, in the works of successive authors. Lesson has enumerated 6,266 species; but Mr. Strickland is of opinion that 5,000 species are pro-

* This and all other information on the subject of distribution is derived from Berghaüs's and Johnston's Physical Atlas: a highly valuable work, which has been referred to on the distribution of reptiles.

† By Keyserling and Blasius.

bably all that can be said to be *accurately* known.* This number is divided into about a thousand genera, and the names and limits of these genera have, from time to time, undergone considerable modification. This will not seem surprising when it is borne in mind that *genera* are merely contrivances adopted by writers for the purpose of conveniently grouping together those species which most nearly resemble each other. The word "species" is applied to "such individuals as are supposed to be descended from a common stock, or which might have so descended."† A *species* has a real existence in nature. A *genus* is an abstract idea, a creation of the mind, liable to be overthrown or upreared, contracted or expanded, according to the mutability of human knowledge.

In this little book we do not purpose entering upon the comparative merits of different systems of classification. That system is the best which is founded, not upon any one set of characters, but upon an intimate knowledge of all. The only true foundation on which it can be reared is that which is afforded by the anatomical structure. Each change of external character is accompanied by a corresponding change of internal organization. "The external parts afford an index to the internal." ‡ The shape of the organs by which the food is taken indicates the form and structure of those by which it is swallowed and digested. Hence, "if we find a bird having a short-beaked bill and curved claws, we shall not be wrong in inferring that it has a wide œsophagus (gullet) and a large membranous stomach." § But our information is incomplete, and our classification imperfect, unless to a knowledge both of external and internal structure, we add that which is to be acquired by the study of the living objects seen in their native haunts. Thus only can we ascertain to what extent each modification of structure is accompanied by a corresponding change of habit: and until this be done, with regard to foreign as well as to native species, we must not suppose that our classification is perfect and unchangeable.

* *Vide* his excellent "Report on the Recent Progress and Present State of Ornithology," Report of British Association, 1844.

† Archbishop Whately's Logic, book iv. chap v.

‡ Macgillivray's British Birds.

§ Idem. This work contains an instructive and interesting series of plates, exhibiting the modifications of the several parts of the alimentary canal in a large number of native birds.

Such are the principles which seem now to be generally recognized, even when there exists considerable difference of opiuion as to the details by which they can most successfully be reduced to practice. The following arrangement is that which has been adopted by some of our leading British ornithologists:—

Order I. RAPTORES—Birds of Prey, as Vultures, Eagles, Owls.

II. INSESSORES—Perchers, as Sparrows, Linnets, Crows.

III. RASORES—Scraping Birds, as Pheasants, Fowls.

IV. GRALLATORES—Waders, as Herons, Bitterns.

V. NATATORES—Swimmers, as Geese, Divers, Gulls.

According to the general plan we have pursued, we should commence with the swimming birds, and gradually ascend to that group which contains the Falcons and the Eagles, which are regarded as the nobles and the kings of the feathered tribes; but the birds usually placed lowest in the scale, such as Gulls and Terns, do not present the slightest resemblance to the creatures which rank highest, and were the last mentioned in the preceding class. Between certain mollusca and fishes we found so great a resemblance, that a question had arisen as to whether a certain species should be regarded as a mollusk or a fish: between fish and reptiles, again, a similar difficulty occurred; but between reptiles and birds, or between birds and mammalia, there can be no such question. The separation is so well marked, that there is no debateable ground, no border territory. The birds stand out apart from the groups on either side, distinctly isolated. No advantage, therefore, accrues from placing the lowest of the birds next to the reptiles, nor those regarded as the highest next to the quadrupeds. Such an arrangement is also open to the objection, that by most writers the different classes are treated of in the order in which they have been here enumerated; and it is desirable that the learner should be accustomed to the same succession of family and genera, in this elementary work, that he will meet with in those of a higher character. For these reasons we have resolved on following the course that is most generally pursued, and beginning with the birds of prey.

We can notice only the leading groups, and even these with great brevity. This must be apparent, when it is recollected that the number of species at present known is perhaps between five and six thousand (p. 308); and that those occurring even in the British Isles amount to between three and four hundred.* We shall therefore only attempt to state what are the points of structure by which the principal divisions are characterized, and bring forward a few of the individuals belonging to each, as exemplifying the habits or economy of their respective families.

Order I.—RAPTORES.—BIRDS OF PREY.

The Raptorial Birds are distinguished by a strong hooked bill and stout muscular legs. Three of the toes are directed forward, and one backward; they are rough below, and armed with powerful, sharp, curved, retractile talons. They are arranged in three families—the Vultures, the Falcons, and the Owls.

I.—VULTURIDÆ.—VULTURES.

"Above, the mountain rears a peak
Where Vultures whet the thirsty beak;
And theirs may be a feast to-night
Shall tempt them down ere morrow's light."†
Byron.

The Vultures have the claws, in general, less curved than either the Falcons or Owls, the feet generally naked, and the head in a greater or less degree divested of feathers. None of them are indigenous in these countries; yet as two have been taken here, they are of course included in our Fauna.

* The Irish species, according to Mr. W. Thompson's Report, published in 1840, were then about 230; and fourteen or fifteen have since been added.

† "Whet the thirsty beak." The idea of *whetting* the beak, though current, is erroneous.

One of these is the Griffon Vulture, of the Alps and Pyrenees (*Vultur fulvus*, *Fig.* 255), caught near Cork Harbour, in 1843.* The food of this species is carrion, on which it gorges to repletion, rarely quitting the prey while a morsel of



Fig. 255.—Griffon Vulture.

flesh remains; so that it is not uncommon to see it perched upon a putrefying corpse for several successive days. It never attempts to carry off a portion, even to satisfy its young, but feeds them by disgorging the half-digested morsel from its maw. It frequents the North of Africa, as well as Europe, and congregates in considerable numbers when the carcase of some large quadruped forms the banquet.†



Fig. 256.—Neopheron.

The other is the Egpytian Vulture (*Neophron percnopterus*, *Fig.* 256), one of which is recorded by Mr. Selby to have been shot in Somersetshire, in 1825. It is this species which Mr. Bruce mentions as frequent in Egypt and about Cairo, where it is called by Europeans "Pharaoh's Hen." These birds are never molested by the natives, but encouraged and protected, because of their services in clearing away filth and offal. "Every group of the natives has a pair of these Vultures attached to it. The birds roost

* Thompson, in Annals of Natural History, vol. xv.

† Bennett.

on the trees of the vicinity, or on the fences which bound the enclosures formed for their cattle."* They differ in size and other particulars from the true or typical Vultures, such as that just mentioned.

The Condor (*Sarcoramphus gryphus*) represents another group remarkable for the "caruncles" or fleshy appendages of the neck (*Fig.* 257), somewhat akin to those seen on the Turkey-cock. Beneath is a white ruff of downy feathers, forming the line of separation between the naked skin above and the true feathers covering the body below. At the early part of this century, such exaggerated ideas, respecting the size of this bird, were current, even among naturalists, that it was compared to the Roc of eastern fable. It was reserved for Humboldt to destroy these exaggerated ideas, and to reduce its powers and dimensions to their true limits. The extent of the wings, when expanded, is usually from nine to eleven feet. Humboldt did not himself see any which exceeded nine: one shot by Mr. Darwin † measured only eight and a half; but it is still said that some attain so great a size as fourteen feet.‡ Borne on these wide-spreading pinions, the Condor may be seen soaring at an elevation of from ten to fifteen thousand feet above the level of the ocean. One is stated to have been seen by Humboldt so high as twenty-two thousand feet. "These birds generally live by pairs; but among the inland basaltic cliffs of St. Cruz," says Mr. Darwin, "I found a spot where scores most usully haunt. On coming suddenly to the brow of the precipice, it was a fine sight to see between twenty and thirty of these great birds start heavily from their resting-place, and wheel away in majestic circles." He describes their flight as beautiful; the Condors moving in large curves, sweeping in circles, descending and ascending without once flapping their wings.



Fig. 257.—Condor.

The species of Vulture which seems to form the connecting link between this family and the Eagle, is that which the

* Yarrell, vol. i.
† Patagonia. Journal, p. 220.
‡ Bennett, "Gardens and Menageries."

natives of the German Alps name the Lammergeyer, or Lamb Vulture. It resembles the Eagle in its confident and upright bearing, and is the largest of European birds of prey, measuring, when fully grown, upwards of four feet from beak to tail, and in the expanse of its wings no less than nine or ten.* It frequents the highest mountain chains in both Asia and Africa. Of its audacity Bruce relates a striking instance. While that celebrated Abyssinian traveller and his servants were at dinner in the open air, with several dishes of boiled goats' flesh before them, one of these Vultures came flying slowly along the ground, and sat down close to the meat, within the ring which the men had made round it. "There were two large pieces, a leg and shoulder, lying upon a wooden platter; into these he trussed both his claws and carried them off." He was shot on his return for a further supply.

II.—FALCONIDÆ.—FALCONS.

"Scaling yonder peak,
I saw an eagle wheeling near its brow,
O'er the abyss; his broad expanded wings
Lay calm and motionless upon the air,
As if he floated there without their aid,
By the sole act of his unlorded will,
That buoyed him proudly up."

J. Sheridan Knowles' "William Tell."

This group is distinguished from the preceding by the sharp curved claws, and by the head being in all cases covered with feathers. It includes the Eagles, Falcons, Kites, and Buzzards.

In entering upon this subject, there is one source of error we should sedulously avoid. It is that which invests with human feelings and passions the inferior animals; which makes us prone to regard one as brave, noble, generous, and humane, and another as cowardly, base, selfish, and unpitying. Tried by such a standard, the Eagle embodies all that is great, the Vulture all that is despicable. We forget that both are birds of prey, destined to fill important, though different, parts in the scale of being, and both alike destitude of those higher motives which the use of such phraseology on our part would imply. With this brief caution, we shall not hesitate to avail

* Bennett.

ourselves of the language of the poet, nor seek to deaden the warm tints which glow upon his pictures.

Two species of Eagle—the Golden and the White-tailed—are known as permanent residents in these countries. The addition of another to our Fauna was an occurrence of some interest to ornithologists. This third species is an inhabitant of the Apennines, and other mountains of central Europe, and is known as the Spotted Eagle (*Aquila nævia*). Mr. R. Davis, of Clonmel, states * that it was shot in the month of January, 1845, on the estate of the Earl of Shannon, county of Cork, and was at the time in a fallow field, devouring a rabbit. Another bird, similarly marked, but reported to have been of a lighter shade of brown, was shot at the same place within a few days afterwards, but was not preserved.

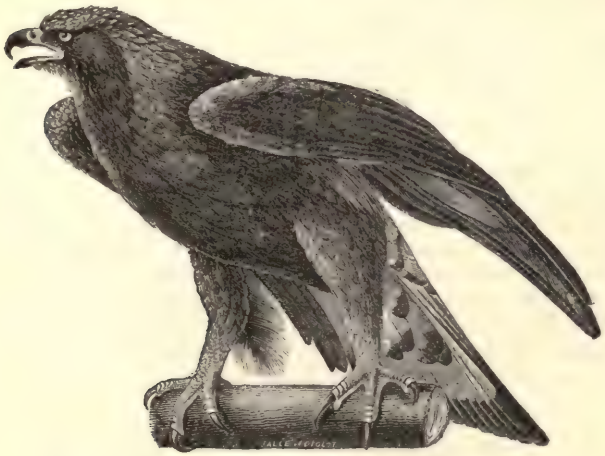


Fig. 258.—Golden Eagle.

The White-tailed, or Cinereous Sea Eagle (*Haliætus albicilla*), is somewhat less in size than the Golden Eagle. It is much more abundant, and it seems in its habits to approach more nearly to the Vultures. We shall, therefore, convey a better idea of the habits of "the wide ruling Eagle," by appropriating our limited space to the Golden Eagle (*Aquila chrysætos, Fig.* 258).

* In a letter to Mr. Yarrell—*vide* British Birds.

This species, though occasionally taken in England, haunts more especially the mountainous districts of Scotland, and of the north and west of Ireland. In Mr. Selby's splendid illustrations of British Ornithology, are two figures of this bird. These have suggested to a reviewer * of that work a description so vivid, that it enables the reader at once to realize, in his own mind, many of its characteristic features.

"The Golden Eagle leads the van of our birds of prey, and there she sits in her usual carriage when in a state of rest. Her hunger and her thirst have been appeased—her wings are folded up in dignified tranquillity—her talons, grasping a leafless branch, are almost hidden by the feathers of her breast—her sleepless eye has lost something of its ferocity—and the Royal Bird is almost serene in her solitary state on the cliff.

"But, lo, the character of the Golden Eagle when she has pounced and is exulting over her prey! With her head drawn back between the crescent of her uplifted wings, which she will not fold until that prey be devoured—eye glaring with cruel joy—neck plumage bristling—tail feathers fan-spread, and talons driven through the victim's entrails and heart—there she is new alighted on the edge of a precipice, and fancy hears her yell and its echo." "The week-old Fawn had left the Doe's side but for a momentary race along the edge of the coppice—a rustle and a shadow, and the burden is borne off to the cliffs of Ben Nevis."

The power of vision in this tribe is very extraordinary. This fact has been long known; so long, indeed, that the classical reader will at once remember that it is mentioned by Homer, in his description of Menelaus:—

> ——————"The field exploring, with an eye
> Keen as the Eagle's, keenest-eyed of all
> That wing the air, whom, though he soar aloft,
> The Lev'ret 'scapes not, hid in thickest shades,
> But down he swoops, and at a stroke she dies."
>
> ILIAD, COWPER'S TRANSLATION, xvii. 674.

Fawns, Lambs, and Hares, with smaller quadrupeds and birds of various kinds, constitute the food. It generally kills its own game, but not invariably. Mr. Thompson † records the

* Blackwood's Magazine, Nov., 1826.

† Papers on the Birds of Ireland, in the Magazine of Zoology and Botany and Annals of Natural History. To this series, with permission of the author, we make frequent reference.

capture of three of these birds at Glenarm Park, County Antrim, the bait employed in each instance being the body of a Duck or a Lamb. So great is the quantity of food they collect, when rearing their young brood, that a poor man in the county of Kerry * got a comfortable subsistence for his family, during a time of famine, by robbing an Eagle's nest. A similar occurrence took place at Glenariff, county of Antrim, in the early part of the present century. "One of a pair of Eaglets, taken from a nest there, was so placed that during the summer its parents supplied it with Rabbits and Hares in such abundance, that its owner obtained a sufficiency of animal food besides for himself and family."†

When intent on following his game, the Eagle evinces great boldness. On one occasion an Eagle appeared above a pack of hounds, as they came to a fault on the ascent of Devis, the highest of the Belfast mountains, after a good chase. "As they came on the scent again, and were at full cry, the Eagle for a short time kept above them, but at length advanced, and carried off the Hare when at the distance of three to four hundred paces before the hounds." ‡ With similar audacity he dashes down among a "pack" § of Grouse, and so "puzzles and confuses the birds, that he seizes and carries off two or three before they know what has happened, and in the very face of the astonished sportsman and his dogs." ‖

It may be observed, that the prey is invariably seized with the talons, the beak being used for the purpose of tearing it up. This is contrary to popular belief; and the error deserves to be pointed out, as we find it pervading the descriptions of some of our most gifted poets; as for example, in the magnificent simile employed by Byron:—

> "Even as the Eagle overlooks his prey,
> And for a moment, poised in middle air,
> Suspends the motion of his mighty wings,
> Then swoops, with his unerring *beak*."
>
> MARINO FALIERO.

* Smith's History of Kerry.

† Thompson.

‡ Idem.

§ The little assemblages of birds, consisting of the parents and full-fledged young, are indicated by sportsmen by names which differ according to the particular birds spoken of, as a *covey* of Partridge, a *pack* of Grouse.

‖ St. John's Wild Sports and Natural History of the Highlands, p 84.

From the small number of Eagles we possess, compared with that of most other native birds, we consider ourselves fortunate in having, on one occasion, come suddenly upon four Eagles, amid their own wild haunts. It was in September, 1833, when ascending Mangerton mountain, at the Lakes of Killarney, near to the little lake called the "Devil's Punch-bowl," we found four of them preying on a full-grown sheep. They rose majestically into the air as we approached. The people who were with us supposed the sheep, being perhaps sickly, had been killed by the Eagles. The flesh of the neck was completely removed, although that of every other part was untouched. We were assured that two Eagles will occasionally pursue a Hare, one flying low, coursing it along the ground, the other keeping perpendicularly above the terrified animal. When the lowest Eagle tires, they change places, and pursue the same system of tactics, until the Hare is completely wearied out. We were told the same circumstance a few days afterwards, near Tralee, and again near Monasterevan. Our informant, in every instance, stated the fact as having fallen under his own knowledge, and not as a matter of hearsay.

The nest or eyrie of the Eagle is associated in our minds with highly poetic imagery;* but it is regarded in a different light by those who live in the vicinity, and suffer by the predatory habits of its inmates. By them it is viewed as the abode of the spoiler, and the nursery of a future race of aërial tyrants. Various means for its destruction are accordingly resorted to; among others, that of lowering a lighted brand into the nest. This was the plan pursued on one occasion at Roshen, County Donegal: the nest was consumed, three unfortunate Eaglets fell scorched and dead to the ground,

* ——————"I was born so high,
Our aiery buildeth on the cedar's top,
And dallies with the wind, and scorns the sun."
RICHARD III. Act i. scene 3.

——————"The Eagle and the Stork
On cliffs and cedar tops their eyries build."
PARADISE LOST, Book vii.

"When the proud name on which they pinnacled
Their hopes is breathed on, jealous as the Eagle
Of her high aiery."
MARINO FALIERO, Act v. scene 1.

and the old birds from that time deserted the mountain.* A similar mode of destruction has been resorted to at times in other localities; and this, no doubt, suggested to Campbell the splendid description of the burning eyrie, in the Wizard's prophetic warning to Lochiel.†



Fig. 259.

The true Falcons are distinguished by the upper mandible of the bill being strongly toothed (*Fig.* 259); by the short, strong legs; the feet with retractile claws of nearly equal size; and the relative proportions of the principal quill-feathers of the wing, the second being the longest. Six species are recorded as British:‡ we shall select for description that which is the most celebrated, the Peregrine Falcon (*Falco peregrinus*). It breeds in rocky districts, and has a wide geographical range. In the British Islands it is found in Scotland, in Wales, in Devonshire and Cornwall; and in other localities where there are high rocks adjacent to the coast. In some parts of Ireland it is not uncommon. "In the four maritime counties of Ulster it has many eyries; and in Antrim, whose basaltic precipices are favourable for the purpose, seven at least might be enumerated."§ But notwithstanding its predilection for the coast, this bird frequents occasionally more inland localities; and Sir J. Sebright states, that numbers of them take up their abode at Westminster Abbey, and

* Thompson.

† We subjoin a portion of the passage referred to:—

> "Ha! laugh'st thou, Lochiel, my vision to scorn?
> Proud bird of the mountain, thy plume shall be torn!
> Say, rush'd the bold Eagle exultingly forth,
> From his home in the dark-rolling clouds of the north?
> Lo! the death-shot of foemen outspeeding, he rode
> Companionless, bearing destruction abroad:
> But down, let him stoop from his havoc on high!
> Ah! home let him speed—for the spoiler is nigh.
> Why flames the far summit?—why shoot to the blast
> Those embers like stars from the firmament cast?
> 'Tis the fire shower of ruin, all dreadfully driven
> From his eyrie that beacons the darkness of heaven."

‡ They are the Jer Falcon, Peregrine Falcon, the Hobby, the Orange-legged Hobby, the Merlin, and the Kestrel. The last, Mr. Thompson remarks, "is common and resident in Ireland, and is of more frequent occurrence than any of the *Falconidæ*."

§ Thompson.

other churches in the metroplis, and make great havoc among the flocks of tame pigeons in the neighbourhood.*

The Peregrine Falcon is the species which, in former times, was most used in these countries for the amusement of hawking. This arose from the docility of the bird, and from its being much more numerous, and, therefore, more easily procured than the Jer Falcon. "The length of the adult Peregrine Falcon is from fifteen to eighteen inches, depending on the size and age of the bird." † The female bird is of much greater size and strength than the male, and to her, in the language of Falconry, the term "Falcon," was exclusively applied. The male was the "Tiercel," or "Tassel;" the reclaimed male the "Tassel gentle." ‡ The female was flown at Herons, or Ducks; the male at Partridges, Magpies, and Rails. The full-grown birds in the wild state, or while unreclaimed, were called "Haggards." §

In the training of the Falcons, great care, skill, and patience were expended. They were taught to come at the "call," or attend to the "lure" of the keeper.‖ They were carried to the field upon "the fist," a thick and often a highly ornamented glove being used to prevent the hand from receiving injury from the strength and sharpness of the claws. At such times, their eyes were covered, or "hooded," with a leather covering, usually surmounted by a small ornamental plume of feathers. Bells of brass or silver were attached to the legs; and through small rings, likewise fixed there, leathern or silken strings were passed, and wound round the hand of the

* Observations on Hawking.

† Yarrell.

‡ "Oh, for a falconer's voice to lure this Tassel gentle back again!"
ROMEO AND JULIET.

§ "As coy and wild as Haggards of the rock."
MUCH ADO ABOUT NOTHING.

‖ To this Shakspeare alludes:—

"My Falcon now is sharp and passing empty;
And, till she stoop, she must not be full gorged,
For then she never looks upon her lure.
Another way I have to man my Haggard,
To make her come, and know her keeper's call."
TAMING OF THE SHREW.

Any one who has read the "Abbot," will remember the quarrel between Roland Græme and Adam Woodcock, about the feeding of a Hawk. In another of Sir Walter Scott's Tales, "The Betrothed," there is a spirited description of a Hawking-match, in which two Falcons are flown at a Heron.

Falconer until the time for "casting off" the bird. When the "quarry"* was seen, the hood was pulled off, the jesses drawn from their rings, and the Falcon at the same time launched into the air. It tried in all cases to soar above and pounce upon the prey, which it transfixed with its powerful talons.

Old records show the great value which was placed in former times upon these birds, and the high prices at which they were occasionally sold. In several places in the "Domesday Book," ten pounds is made the optional payment instead of finding a Hawk. It is said that in one instance, about two hundred years ago, so much as a thousand pounds were paid for a pair. By the 34th Edward III., it was made felony to steal a Hawk; and to take its eggs, even on a person's own grounds, was punishable with imprisonment for a year and a day, besides a fine at the king's pleasure. Thus prized and protected, and used only by the wealthy and the noble, these birds became the appendage of their state as well as of their pastime.

References to Hawking, and its details, are of constant occurrence in our old ballads.† Shakspeare, who so invariably "holds the mirror up to nature," hesitates not to introduce the language of Falconry, in giving utterance to the perturbed and distracting meditations of Othello:—

> ——— "If I do prove her haggard,
> Though that her jesses were my dear heart-strings,
> I'd whistle her off, and let her down the wind
> To prey at fortune."

The rapid flight of the Falcon is very remarkable. An instance is recorded of one belonging to Henry IV., King of France, which traversed the distance between Fontainebleau and Malta, not less than 1,350 miles, in twenty-four hours. In this case, supposing it to have been on the wing the whole time, its rate of flight must have been nearly sixty miles an hour; but, as Falcons do not fly by night, it was probably not more than sixteen or eighteen hours on the wing, and its rate must, therefore, have been seventy or eighty miles an hour.

* The bird flown at by a Hawk was so named.

† *Vide* the Gay Goshawk, and the Broomfieldhill, in Minstrelsy of the Scottish Border. Sometimes the epithet, "gay Goshawk," is applied figuratively; thus, in the ballad of Fause Foodrage, in the same collection:—

> "And ye maun learn, my gay Goshawk,
> Right weel to breast a steed."

The Peregrine Falcon resembles the Golden Eagle in the indifference evinced occasionally towards sportsmen and dogs. An instance of this is thus narrated by Mr. Thompson:—"Mr. Sinclaire, when once exercising his dogs on the Belfast mountains, towards the end of July, preparatory to Grouse-shooting, saw them point; and, on coming up, he startled a male Peregrine Falcon off a Grouse (*Tetrao Scoticus*) just killed by him; and very near the same place my friend came upon the female bird, also on a Grouse. Although the sportsman lifted both the dead birds, the Hawks continued flying about; and on the remainder of the pack, which lay near, being sprung by the dogs, either three or four more Grouse were struck down by them, and thus two and a-half or three brace were obtained by means of these wild birds, being more than had ever been procured out of a pack of Grouse by his trained Falcons."

We record, from the same source, another illustrative anecdote:—"In October, 1833, a female Peregrine Falcon of Mr. Sinclaire's—a bird of that year, and, consequently, but a few months old—got loose in the hawk-yard, and killed a male of her own species, a year or two older than herself, and which had the power of moving at least a yard from his block. She had nearly eaten him when a person entered the yard to feed them, which he did once daily, at a regular hour. This female bird was 'full fed' the day before, and had never got more than one meal in the day."



Fig. 260.—Goshawk.

The Hawks, as distinguished from the true Falcons, have the legs more slender, the wings shorter, the fourth quill the

longest, and the middle toe much longer than the lateral ones. There are but two British species, the Goshawk (*Fig.* 260) and the Sparrowhawk.

The Goshawk (*Astur palumbarius*) is equal in size to the largest of the Falcons. Its flight is low, and it was formerly flown at Hares, Rabbits, Grouse, and Partridges. Its prevailing tint is greyish; hence the line in one of the Border Ballads:—

"The boy stared wild, like a *grey* Goshawk."—FAUSE FOODRAGE.

The Sparrow-hawk (*Accipiter fringillarius*) has been well characterized by Mr. St. John as a "bold little freebooter," and he thus records examples of its audacity:—"A Sparrow-hawk pursued a Pigeon through the drawing-room window, and out at the other end of the house through another window, and never slackened his pursuit, notwithstanding the clattering of the broken glass of the two windows they passed through. But the most extraordinary instance of impudence in this bird that I ever met with, was one day finding a large Sparrow-hawk deliberately standing on a very large Pouter-pigeon, on the drawing-room floor, and plucking it, having entered in pursuit of the unfortunate bird through an open window, and killed him in the room."*

The Kite (*Milvus Ictinus*, *Fig.* 261) "is readily distinguished among the British *Falconidæ*, even when at a distance on the wing, by its long and forked tail," and by its easy and graceful flight.



Fig. 261.—KITE.

"It has now become comparatively rare in England."† In Ireland, according to Mr. Thompson, the bird is extremely rare, though the name is applied to other species of the family, and particularly to the Common Buzzard (*Buteo vulgaris*). The Honey Buzzard, a native of the south of Europe, and of eastern climes, has been shot on several occasions in England, and has, in one instance, occurred in the vicinity of Belfast.‡

The Harriers form the remaining group of "the Falcon

* Wild Sports and Natural History of the Highlands.
† Yarrell. ‡ Thompson.

family." One of them, the Hen-Harrier, is a most skilful rat-catcher. "Skimming silently and rapidly through a rick-yard, he seizes on any incautious Rat that may be exposed to view; and, from the habit this Hawk has of hunting very late in the evening, many of these vermin fall to his share. Though of so small and light a frame, the Hen-Harrier strikes down a Mallard without difficulty, and the marsh and swamp are his favourite hunting-grounds."* We may here remark, that the whole of the predaceous birds have the power of rejecting from their stomach, in the form of oblong balls, the undigested portions of their food, consisting of bones, hair, and feathers.

III.—OWLS.—STRIGIDÆ.

"The Owl shriek'd at thy birth: an evil sign."—SHAKSPEARE.
KING HENRY VI. Part iii. Act v. scene 6.

The nocturnal birds of prey form the third and last division of the present order, and constitute the well-marked family of the Owls (*Fig.* 262). In the dusk of the evening they sally forth, with eyes eminently adapted for the diminished light, and with wings whose movement is so inaudible, that, to use the words of an eloquent writer, "a flake of snow is not winnowed through the air more softly silent." Their strange appearance, grotesque attitudes, discordant screams or continuous hootings, have made them be regarded by the uneducated as birds of ill omen.† The progress of knowledge dispels these idle fears, and converts a source of terror into one of the countless rills of poetry and tradition.



Fig. 262.—OWL.

* St. John's Wild Sports of the Highlands.

† Thus among the prodigies which portended the death of Cæsar:—
——"Yesterday, the bird of night did sit,
Even at noonday, upon the market-place,
Hooting and shrieking."—JULIUS CÆSAR, Act i. scene 3.

Owls differ much in dimensions, some even approaching in size to the Eagles. Among these the Snowy Owl stands conspicuous; it is a native of high northern latitudes, but has been taken on many occasions in these countries. The species most common in England and Ireland is the White or Barn Owl (*Strix flammea*). They frequent not barns only, but unoccupied buildings of any kind. The "ivy-mantled tower" is a congenial abode. They leave their retreat about an hour before sunset, to hunt for mice, which form the principal food of themselves and their young; and in doing so they "beat the fields over like a setting dog."* The numbers of mice destroyed by a breeding pair of Owls must be enormous, and the service they thus perform very great, to the farmer, the planter, and the gardener. "I knew an instance," continues Mr. St. John, † "where, the Owls having been nearly destroyed by the numerous pole-traps placed about the fields for the destruction of them and the hawks, the rats and mice increased to such an extent on the disappearance of these their worst enemies, and committed such havoc among the nursery-gardens, farm-buildings, &c., that the proprietor was obliged to have all the pole-traps taken down; and the Owls being allowed to increase again, the rats and mice as quickly diminished in number."

Mr. Thompson mentions that a pair of White Owls had their nest and young in a loft appropriated to Pigeons in the town of Belfast. On the shelf beside the young Owls, the number of dead mice and rats observed remaining after the night's repast, varied from six to fifteen. No attempt was ever made by the Owls to molest either the Pigeons or their young; and there is strong reason to believe that it is only in the dearth of other prey that this Owl attacks any of the feathered tribe.

In this particular it differs from the Eagle Owl, a species which inhabits the north of Europe, and has occasionally been taken in these countries. A Swedish gentleman, who lived near a high mountain on which a pair of these birds had built their nest, was witness of the following instance of their affectionate solicitude for their young:—One of the young birds, which had quitted the nest, was taken by his servants, and shut up in a hen-coop. "On the following morning a

* Natural History of Selborne.
† Wild Sports of the Highlands.

fine young Partridge was found lying dead before the door of the coop. It was immediately concluded that this provision had been brought there by the old Owls, which, no doubt had been making search in the night-time for their lost young one. And such was, indeed, the fact; for night after night, for fourteen days, was this same mark of attention repeated. The game which the old ones carried to it consisted chiefly of young Partridges, for the most part newly killed, but sometimes a little spoiled."* In South America there are Owls which live in burrows excavated by themselves, or by a little quadruped allied to the Rabbit.

Order II.—INSESSORES.—PERCHING BIRDS.

"The ousel-cock,† so black of hue,
With orange-tawny bill:
The throstle, with his note so true;
The wren, with little quill;
The finch, the sparrow, and the lark;
The plain-song cuckoo grey."—Shakspeare.

The "Perchers," or, to use the scientific term which has the same meaning, the *Insessores*, are those birds which are not predaceous like the Falcon; which do not scrape the ground like the barn-door fowl; which are not wading birds like the Heron, nor swimming birds like the Duck. The tribe may be thus indicated by a series of negatives; and it embraces a great variety of birds, differing widely in structure and habits. Even within the narrow limits of our islands, above a hundred species belonging to the present order are enumerated.

It is obvious that these birds have no exclusive claim to be regarded as Perchers; for Owls, Eagles, and other birds, perch also. But this habit, taken in connexion with peculiarities of structure, suggests a term which, though not strictly applicable to them alone, is a very convenient one, and not likely to mislead. It naturally suggests a question—"How do birds perch?"—by what especial contrivance are they enabled to maintain a firm hold even in sleep, at which time, we know,

* Familiar History of British Birds, vol. i. p. 192.

† The Blackbird is sometimes called by this name, and is the species here referred to.—*Vide* Yarrell, note on Ring Ouzel.

our hands so soon relax in their power of grasping? The mechanism is, at the same time, the most simple and the most effectual. Every one has probably seen the lower part of the leg of a Turkey when cut off,* preparatory to the fowl being cooked; and, if so, may have, when a boy, amused himself by pulling the tendons, which, acting upon the claws, enabled him to make them contract or open at pleasure. What he has done by pulling the tendons is done in the perching birds by the bending of the leg, and, by this simple act, the bird, without effort, retains its hold, and does so securely, even on one leg. The placing of the head under the wing brings the centre of gravity more nearly over the feet, and thus gives additional stability.

From the number of species comprised in the *Insessores*, it is convenient to divide the order into four groups, which are again subdivided into families, genera, and species. The four groups are established on very obvious characters, connected principally with the form of the beak or of the foot. Some, as for example the Thrush and the Robin, have on the upper mandible of the bill, a notch or tooth, somewhat similar to that of the Falcons (*Fig.* 263). These constitute the group of tooth-billed birds; but the man of science, instead of the English term, which would only be understood here, employs a compound Latin term (*Dentirostres* †), which means the same thing, and is understood by men of science in every part of the world. The Sparrow has a bill of a different shape (*Fig.* 264); it is conical. Hence the Sparrow belongs to another group, those with cone-shaped bills (*Conirostres*). The third consists of those birds which are remarkable for their powers of climbing. In them the toes are most usually arranged in pairs, two turned forwards and two backwards, as may be



Fig. 263.



Fig. 264.

* It may here be remarked that the true leg of a bird is the part to which that name is given when a fowl is brought to table. The part called the leg in the living bird lies between the leg, properly so called, and the foot, and is analogous to that part of our foot which lies between the ankle and the toes.

† Latin—*Dens*, a tooth; *rostrum*, a beak.

seen in the foot of the Cuckoo or the Woodpecker (*Fig.* 272). The term applied to the group is that of *Scansores* or climbers. The fourth is composed of those birds whose beaks are so wide and gaping that they appear as if cleft; hence they are named *Fissirostres*. The Swallow or Swift, in chase of their insect prey, are familiar examples of this structure. A much maligned bird, that also feeds upon insects, exhibits this peculiarity. We allude to the Goatsucker (*Caprimulgus Europœus*, *Fig.* 265), which popular credulity has accused in Italy of sucking goats, and here of sucking cows, and inflicting a fatal distemper upon weaning calves. We have thus four tribes of perching birds:—



Fig 265.

I. Tooth-billed, *Dentirostres.*
II. Conical-billed, *Conirostres.*
III. Climbers, *Scansores.*
IV. Gaping-billed, *Fissirostres.*

We shall now notice some well-known individuals of each of these tribes, though necessarily with great brevity, devoting our space principally to those which are natives, in preference to the more brilliant inhabitants of foreign climes.

Tribe I.—TOOTH-BILLED BIRDS.—DENTIROSTRES.

"Brisk Robin seeks a kindlier home;
Not like a beggar is he come,
But enters as a looked-for guest,
Confiding in his ruddy breast,
As if it were a natural shield
Charged with a blazon on the field,
Due to that good and pious deed,
Of which we in the ballad read."—Wordsworth.

*Laniadæ.**—The Shrikes or Butcher-birds bear some resemblance in habit, and in the curved projection of the upper part of the bill, to the birds of prey. "The Grey Shrike," says Mr. Yarrell, "feeds upon mice, shrews, small birds, frogs, lizards, and large insects; after having killed its prey, it fixes

* Latin—*Lanius*, a butcher.

the body on a forked branch, or upon a sharp thorn, the more readily to tear off small pieces from it. It is from this habit of killing and hanging up their meat, which is observed also in other Shrikes, that they have been generally called Butcher-birds. They are not plentiful in these countries.

Passing by the Fly-catchers (*Muscicapidæ*), of which there are only two native species, we come to that of the Thrushes (*Merulidæ*). To this family belongs the Water Ouzel (*Cinclus aquaticus*), a bird which frequents rocky streams, and the banks of rapid rivers in mountainous districts. "With the romantic and picturesque in scenery," says Mr. Thompson, "this bird is associated, frequenting the stream only so far as it can boast of such charming accompaniments; whenever it descends to the lowlands to move sluggishly through the plain the Water Ouzel forsakes it, to continue in its upland haunts."

A question has arisen in reference to the habits of this bird, whether it can or cannot walk underneath the water. Mr. St. John, the latest writer upon the question, expressly states, in opposition to Mr. Waterton, that on two or three occasions he has seen the Water Ouzel walk deliberately down into the water, and run about on the gravel at the bottom, scratching with his feet among the small stones, and picking away at all the small insects and animalcules which he could dislodge.*

The Missel Thrush (*Turdus viscivorus*) is in England considered only as an early songster, but in Ireland its song may be heard at every season of the year, with the exception of the moulting season. That of the Fieldfare, a migrating Thrush that arrives from the north towards the end of October, and remains in these countries in large flocks during the winter, is described as soft and melodious. But the present genus contains two species, which bear away the prize in minstrelsy from any of their associates—the Song Thrush (*Turdus musicus*), and the Blackbird (*T. merula*), "The Mavis and Merle" of the Border Ballads. The poet has in one line characterized both the song and the haunts of the one last mentioned:—

> "The Blackbird whistles from the thorny brake."
>
> THOMSON'S SEASONS.

The Thrush usually haunts woods and small plantations, but we have heard its song poured out on one of the wildest

* Wild Sports of the Highlands.

mountain tracts in the County of Antrim, the singer being perched upon a ragweed. Mr. Thompson records an instance in which one of these birds built five nests in the course of one season, and reared seventeen young. We have already adverted (p. 181) to the tantalizing proof we experienced of its partiality for one of our most beautiful land shells, or rather for its occupant, as food.

Sylviadæ.—The family we have next to mention is the most musical in Europe, and some of its members have attained the highest reputation as vocalists. Among those best known may be mentioned the Redbreast, Sedge-Warbler, Nightingale, Blackcap Warbler, and Willow Wren. The brief notice we can give shall be bestowed upon the Redbreast and the Nightingale.

We have been taught to love the Robin Redbreast (*Sylvia rubecula*), associated as it is with recollections which the wear and tear of after life can never efface.* Those who have lived in this country have seen him during the summer feeding on earth-worms, caterpillars, berries, and fruits; and in winter presenting himself to receive from the hand of man the food which the frozen earth withholds. His habits, when he first ventures into the cottage to pick up the proffered crumbs, have been truly described by Thomson:—

> ——————"Then hopping o'er the floor,
> Eyes all the smiling family askance,
> And pecks, and starts, and wonders where he is."

"The sprightly air of this species," says Mr. Yarrell, "the full dark eye, and the sidelong turn of the head, give an appearance of sagacity and inquiry to their character, which, aided by their confidence, has gained them friends; and the Robin has accordingly acquired some familiar domestic name, in almost every country of Europe."

The bird seems at times to have indulged in some whimsical fancies as to the situation of his nest. "A pair took up their abode in the parish church of Hampton, in Warwickshire, and affixed their nest to the church Bible, as it lay on the reading-

* Shakspeare mentions the bird by the old Saxon name—the Ruddock, and refers to its performance of the same office as that attributed to it in the well-known ballad:—

> ——————"The Ruddock would,
> With charitable bill, bring thee all this,
> Yea, and furred moss besides, when flowers are none,
> To winter-ground thy corse."—CYMBELINE, Act iv. scene 2.

desk. The vicar would not allow the birds to be disturbed, and therefore supplied himself with another Bible, from which he read the lessons of the service."* One pair built repeatedly adjoining a blacksmith's shop; but neither the noise of the adjacent forge, nor frequent visits disturbed them.† Another constructed the nest in a hole in the timbers of a vessel undergoing repairs in the dry dock at Belfast, while the deafening process of driving in what are called the *tree-nails* was carried forward, occasionally close to the nest.‡ But a more extraordinary selection was made by one which had been frequently expelled from a bird-stuffing room, where the window was kept open, and is thus recorded by Mr. Thompson:—"Finding that expulsion was of no avail, recourse was had to a novel and rather comical expedient. My friend had, a short time before, received a collection of stuffed Asiatic quadrupeds, and of these he selected the most fierce-looking Carnivora, and placed them at the open window, which they nearly filled up, hoping that their formidable aspect might deter the bird from future ingress; but the Redbreast was not to be so frightened from its 'propriety,' and made its *entrée* as usual. Its perseverance was at length rewarded by a free permission to have its own way, when, as if in defiance of the *ruse* that had been attempted to be practised upon it, the chosen place for the nest was the head of a shark!"

The Nightingale (*Sylvia luscinia*, *Fig.* 265, A.) stands pre-eminent in all the requisites for first-rate song. The volume, quality, and execution of its voice are unrivalled among British birds, and its powers appear still more extraordinary, taken in connexion with the diminutive size of the musician.§ It is a native



Fig. 265, A.—Nightingale.

* From the pleasing little volumes to which we have more than once referred, the "Familiar History of Birds," by the Bishop of Norwich, vol. ii. p. 35. The fact is given on the authority of a writer in Magazine of Natural History, No. 31.

† Yarrell, from the Field Naturalists' Magazine.

‡ Thompson. The vessel was the Dunlop.

§ Yarrell.

of southern climes, and appears in England in April, the arrival of the males preceding that of the females from ten to fourteen days. It is by no means generally distributed. It does not appear to frequent Cornwall nor Wales, and is rarely heard to the north of Warwickshire; it is consequently absent from Scotland and the adjoining islands, and is altogether unknown in Ireland.

The song of woe,* which the poets have attributed to the Nightingale, is entirely fanciful. To the solitary and sentimental muser, the notes may have seemed plaintive in the extreme, and suggested the idea of the widowed bird mourning for her mate. But the songs of birds are not the vehicle of sorrow, but the expression of joy; and in most cases they proceed from the male bird, either while wooing his partner, or cheering her in the performance of her maternal duties. The song of the Nightingale is the outpouring of joy, and not of sadness, and is due mainly, if not exclusively, to the male.

The beautiful golden-crested Wren (*S. regulus*), the various species of Titmice (*Parus*), the vivacious and attractive Wagtails (*Motacilla*), can only be mentioned. To them succeed the Pipits (*Anthus*) frequenting the wood, the meadow, or the coast, according to the different habits and food of the several species. They lead by easy stages to the True Larks, which commence the next group — those which have the bills conical.



Fig. 266.—Humming-bird

Before, however, giving attention to them, we would like to pause for a moment on tropical birds remarkable for their slender bills, and hence spoken of by some writers by a

* "Here can I sit alone, unseen of any,
And to the Nightingale's complaining notes
Tune my distresses and record my woes."
Two Gentlemen of Verona, Act. v. scene 4.

term denoting this peculiarity (*Tenuirostres*). They cannot be better exemplified than by the Humming-birds (*Fig.* 266), a tribe which includes some of the smallest and most beautiful of the whole feathered race, combining the richness of flowers and the brilliancy of gems. They take their name from the manner in which they hover over flowers, keeping up a humming-noise by the vibration of their wings, the motion of which at such times is so rapid as to be scarcely visible. Mr. Darwin says they reminded him of the sphinx moths, and considers that insects rather than honey are the objects of their search —an opinion which an examination of the stomachs of several specimens which were shot confirmed, as the remains of insects were found in all.*

Tribe II.—CONICAL-BILLED BIRDS.—CONIROSTRES.

"The Daw,
The Rook and Magpie, to the grey-grown oaks
* * * * * *
* * * direct their lazy flight."
THOMSON'S "SUMMER."

The first bird we shall mention—the Sky-lark—does not exhibit that form of bill which gives name to the tribe; the true representatives of the group must be sought, not upon the outskirts, but towards the centre of the territory. The hinder toe is apparently disproportioned to the others by its great length; but this peculiarity, which unfits the Lark for perching, enables it to walk with ease upon the grass, and spring upwards ere the wings are expanded for flight. The food consists of seeds, worms, and insects. The bird delights in dusting itself; a process in this as in others resorted to, for the purpose, it is supposed, of freeing themselves from small parasitic insects. In autumn, Larks collect in large flocks, become fat, and in some parts of England are captured by nets in large numbers, and sold as a delicacy.

But it is not any one of these circumstances, nor all of them together, that gives the Lark its fascinations, when in early spring we listen to the flood of music it pours on the

* Journal, pages 37, 330.

awakening earth, or hearken to the cheerful influence of its song as described by Milton:—

> "To hear the Lark begin his flight
> And singing startle the dull night;
> From his watch-tower in the skies,
> 'Til the dappled morn doth rise,
> Then to come in spite of sorrow,
> And at my window bid good-morrow."
>
> L'ALLEGRO.

Calculations as to the usefulness of the bird are lost sight of; and a part from them altogether, men, by universal consent, pay homage to the joy-inspiring minstrel, whose note is ever fresh and ever gladsome. By Thomson he is described as

> ——————"The messenger of morn,
> Ere yet the shadows fly, he mounted sings,
> Amid the dawning clouds, and from their haunts
> Calls up the tuneful nations."—SPRING.

The Lark is universally distributed over Europe, and descriptions akin to these are everywhere current. Who then could wish that the Zoologist and the Poet should move in separate paths? Who would not desire that the Poet should proclaim the truths which the objects around him teach, and lead man to regard them as volumes which the Creator has unfolded for his perusal?

Fringillidæ.*—Associated with the Larks in one extensive family containing nearly thirty native species, are the Buntings, the Finches, Sparrows, Grosbeaks, and some who as songsters are justly prized, as the Goldfinch, the Linnet, and the Bullfinch; also the singular Crossbill, whose beak would seem deformed and useless, did not a knowledge of the manner in which it is employed in opening the cones of the fir-tree show that it is in reality a most efficient instrument for its destined purpose.

Sturnidæ.—The Common Starling (*Sturnus vulgaris*,† *Fig.* 267) is the representative of another family. It is well known for its power of imitating sounds; and from an early age has in our minds been associated with Sterne's well-known words,

* Latin *Fringilla*, a Chaffinch.

† This figure, and that of the Gull (284) are copied from Bewick.

"I cannot get out;"* and with the angry resolution of Hotspur.†

The Starling is a migratory species; but a difference of opinion prevails among naturalists as to the extent and regularity of the migration. The most recent record on the subject is that afforded by Mr. W. Thompson,‡ relative to the appearance of the Starling in the neighbourhood of Belfast. He informs us that this occurs towards the middle or latter



Fig. 267.—Starling.

end of September, and continues for about six or eight weeks; that the flocks are seen every fine morning coming from the north-east and continuing the same course; and that each flock consists of from half-a-dozen to two hundred individuals, and arrives generally between eight and ten o'clock. "At the season of their earliest appearance there is daylight between four and five o'clock in the morning, and their not being seen before eight o'clock, leads to the belief that they have

* "The Captive."

† "I'll have a Starling shall be taught to speak
Nothing but Mortimer."
King Henry IV., Part i. Act i. scene 3.

‡ Annals and Magazine of Natural History.

left some distant place at an early hour." The greatest number ever seen in one day in their course of flight, amounted to 1500; and the entire number thus seen during the migratory period, to about 15,000.

Mr. Yarrell mentions localities in which these birds congregate by thousands; in one case in the vicinity of Bristol, by millions. Their food consists of worms, insects, snails, berries, and grain. They build in ruins, old trees, church-steeples, rocks, and holes about buildings; and Mr. Ball has remarked, that the celebrated round towers of Ireland are favourite nesting-places. The evolutions of a large body of Starlings before retiring to rest have been so graphically described in the "Familiar History of Birds," that it would be doing injustice to the learned and right reverend author, not to give the words there employed.

"At first they might be seen advancing high in the air, like a dark cloud, which in an instant, as if by magic, became almost invisible, the whole body, by some mysterious watch-word or signal, changing their course, and presenting their wings to view edgeways, instead of exposing, as before, their full expanded spread. Again, in another moment, the cloud might be seen descending in a graceful sweep, so as almost to brush the earth as they glanced along. Then once more they were seen spiring in wide circles on high, till at length with one simultaneous rush down they glide, with a roaring noise of wing, till its vast mass buried itself unseen, but not unheard, amid a bed of reeds projecting from the bank, adjacent to the wood. For no sooner were they perched than every throat seemed to open itself, forming one incessant confusion of tongues."



Fig. 268.—Bird of Paradise.

This is perhaps the place where reference may be made to the Birds of Paradise (*Fig.* 268), which, according to Eastern

fable, lived upon dew and vapour, and carried on without descending to earth all the functions of life, even to the production of their eggs and young. They have justly been said, from the extreme beauty of their plumage, to hold the highest rank among the feathered glories of the creation. They are limited to New Guinea, or as it is frequently called, the country of the Papuas, and some of the adjacent islands of the South Pacific Ocean. The natives of these countries, when preparing and drying the skins, were in the habit of removing the feet of the bird. The skins in this state were sold to the Malays, carried into India, and thence conveyed into Europe. Here we have the origin of the superstitious ideas with which these birds were formerly associated, arising from the supposed want of legs. The legend has been commemorated by Linnæus, who applied to the best known species the appellation, "footless;"* and it has been enshrined in the harmonious lines of the poet:—

> ——————"The footless fowl of heaven that never
> Rest upon earth, but on the wing for ever,
> Hovering o'er flowers their fragrant food inhale,
> Drink the descending dew upon its way,
> And sleep aloft while floating on the gale."
>
> SOUTHEY'S "CURSE OF KEHAMA."

Corvidæ.—The Starling, which has been already noticed, and the Raven, the Magpie, and the Jay, which are members of the present family, possess the power of imitating the human voice in a higher degree of perfection than any other British birds. One example of this has been mentioned in a preceding page (p. 307).

The Raven labours under the misfortune of being regarded as a bird of ill omen.† High rocks and other places, where danger may best be descried, are his favourite haunts. His food is various, emmets, reptiles, birds and their eggs, fish, and carrion; like other species, he is partial to chickens and young ducks; and we were assured on one occasion by a credible witness that he had seen a Raven alight among a flock of full-

* *Paradisea apoda.*

† ——————"The Raven himself is hoarse
That croaks the fatal entrance of Duncan
Under my battlements."—MACBETH.

——————"Oh, it comes o'er my memory,
As doth the Raven o'er the infected house,
Boding to all!"—OTHELLO.

grown ducks, give one of them a few blows, throw it on its back, and forthwith begin to tear it up. Such audacity is of extremely rare occurrence.

It is pleasant to think of birds in connexion with the localities in which they were observed. Our rambles along the shore of the County Antrim have given us frequent opportunities of noticing the Hooded-crows (*Corvus cornix*) upon the beach: they were not usually in pairs; three were more frequently seen than two, and five than four. There, too, near the basaltic headlands of that noble coast, we have gazed with pleasure on the Chough (*Fregilus graculus*), as it sailed above our head, the brilliant red of its legs contrasting beautifully with the glossy bluish-black of the plumage.

There is, however, no bird of the family so well known throughout all the cultivated parts of the kingdom as the Rook (*Corvus frugilegus*), and as we prefer dwelling on that which is common rather than on that which is rare, we devote to its habits the space at our command.

It is a social bird, fond of living about the abodes of man, and even of building in the heart of crowded cities. But it is not with such haunts that its appearance is usually associated, but with time-honoured mansions, and more especially lofty trees, their chosen abodes during successive generations.

Washington Irving has written respecting these birds,* in his usual agreeable style. "They are," he says, "old established housekeepers, high-minded gentlefolk, that have had their hereditary abodes time out of mind;" and he goes on in the same amusing manner to describe, what "rather derogates from the grave and honourable character of these ancient gentlefolk, that during the architectural season they are subject to great dissensions among themselves; that they make no scruple to defraud and plunder each other, and that sometimes the rookery is a scene of hideous brawl and commotion, in consequence of some delinquency of the kind."

Mr. Macgillivray, when visiting a rookery† at night, "was surprised to hear several rooks uttering a variety of soft clear modulated notes, very unlike their usual cry. In the interval I could distinguish," says he, "the faint shrill voice of the newly-hatched young, which their mothers, I feel persuaded, were fondling and coaxing in this manner. Indeed the sounds

* The Rookery, Bracebridge Hall.

† British Birds, vol. i. p. 549.

were plainly expressive of affection, and a desire to please." The young who are the objects of this solicitude suffer greatly in seasons of drought. Mr. Knapp mentions that, in the hot summer of 1825, many perished from want;* the mornings were without dew, few or no worms could be obtained, and all the young were found dead under the trees, having expired on their roostings.

The supply of food involves a question of much importance to the farmer; namely, whether Rooks do him most good or most evil? If it were possible to keep a regular account of all their proceedings and their results, which way would the balance lie? Should he regard the Rooks as friends or as enemies? The question when considered for a moment expands, and presents itself under a new form, and comprises not Rooks alone, but all those "trooping birds" that live partly upon insects, and partly upon grain and other produce.

The opinion of those who have most attentively weighed the evidence on both sides is, that the continual benefit which Rooks confer by the destruction of snails, worms, and insects in their several states, far more than compensates for the occasional injury they inflict. It is needful at seed-time to guard the newly-sown grain, and the potato "sets" against their depredations; that being done, offer them no molestation. There are numerous insects that, in the Caterpillar state, eat away the roots of grain or grass crops, while others in different stages make their attacks above ground, and at a later season. The larvæ of the Cockchafer,† of the Click Beetles,‡ and of the Harry-longlegs,§ are all underground feeders; and sometimes when Rooks pull up grass and scatter it about, its roots have been already destroyed by the unseen devastators, for which the birds are searching. "A gentleman," says Mr. Jesse, "once showed me a field which had all the appearance of being scorched as if by a burning sun in dry hot weather. The turf peeled from the ground as if it had been cut with a turfing-spade, and we then discovered that the roots of the grass had been eaten away by the larvæ of the Cockchafer, which were found in countless numbers at various depths in the soil."‖ The Rooks, which evince remarkable quickness in detecting

* Journal of a Naturalist.
† *Melolontha vulgaris.*
‡ Elateridæ.
§ Tipulidæ.
‖ Gleanings of Natural History.

such spots, were in reality benefactors, not destroyers. Numerous other examples of a similar kind might be brought forward. To these might be added others no less instructive, in which the Rooks in certain districts have been extirpated, so great an increase of the insect enemies of the agriculturist took place, that the crops, for two or three successive seasons, were utterly destroyed, and the farmers obliged, at some trouble and expense, to reinstate the Rooks in order to save their crops.

In 1831 or 1832 we noticed great quantities of the skulls and other bones of Rooks lying on the shores of Lough Neagh, and understood that during a dense fog multitudes of these birds had perished in the waters, and that their bodies had afterwards been drifted ashore. After the great hurricane of the 7th of January, 1839, many thousands were picked up dead on the shores of a lake some miles in length, in the County of Westmeath, with extensive rookeries on its borders.*



Fig. 269.—Hornbill.

The wary Magpie, the busy Jackdaw, and the cheerful Jay—a bird unknown in the northern parts of Ireland—all belong to the present family; and various are the petty larcenies which have been laid to their charge. One of the most perplexing occurred at Cambridge, where the Daws took a fancy to employ in the construction of their nests, the wooden labels used in the Botanic Garden, for the names of seeds and plants; and to such an extent did they avail themselves of these materials, that so many as eighteen dozen of labels were

* This singular fact was communicated to Mr. R. Ball of Dublin, by Dean Vignolles, on whose property it occurred.

found in the shaft of a single chimney in which these birds were in the habit of building.*

There are some foreign birds which, in their general habits, approach to the present family. They are remarkable for the excrescence by which the beak is surmounted, and from which they derive their name of Hornbills (*Fig.* 269). This singular appendage is extremely light, consisting of numerous cells filled with air, which in fact penetrates with great facility every part of their skeleton. The African species are described as living on small Birds, Mice, Reptiles, and even carrion, and only descending to vegetable diet when better fare is not attainable. The Asiatic species seem more restricted to fruits, and in the Molucca islands live chiefly upon nutmegs. In the great size of the beak, and in the habit of swallowing their food whole, the Hornbills bear a resemblance to the Toucans, a family of climbing birds which inhabit the thick forests of tropical America, and whose principal food is the eggs and the young of birds.

Tribe III.—CLIMBING BIRDS.—SCANSORES.

"In gaudy robes of many coloured patches,
The Parrots swung like blossoms on the trees,
While their harsh voices undeceived the ear."
Montgomery's "Pelican Island."

We cannot give better examples of the climbing birds than those furnished by the Parrots, Cockatoos, and Macaws (*Fig.* 270) of tropical countries; those beautiful birds, many of which are domesticated in our houses, and which are uniformly one of the principal points of attraction in our Zoological gardens. The formation of the foot and of the beak qualifies them in a pre-eminent degree to act as climbing birds.

The Woodpeckers, among British birds, belong to the present group. Their food consists of insects in different states, for which they search under the bark of trees, digging into

* Stated by Mr. Yarrell, and by Mr. Jenyns, on the authority of Mr. Denson.

the wood of such as are decayed. The point of the tongue is furnished with hairs pointing backwards (*Fig.* 271), and the tongue has a peculiar and very effectual apparatus by means of which it is launched at the insect prey. The tail, in conjunction with the two feet, acts as a tripod (*Fig.* 272), and gives the bird the requisite stability while proceeding with its operations.



Fig. 270.—Macaw.

A favourite bird, remarkable both for its diminutive size and for its large family, must not be unnoticed. We allude to the Wren (*Troglodytes Europæus*). It comes about our dwellings almost with the confidence of the Robin, and like that bird, has in its favour, the potent recommendation which clings to the stories and lays of childhood.

But perhaps there is no individual bird whatever whose habits are so peculiar as those of the Cuckoo (*Cuculus canorus*), and none whose cheerful note in the spring awakens more gladsome feelings. It builds no nest, but drops



Fig. 271.—Skull of Woodpecker.

its eggs into the nests of other birds; one only is supposed to be dropped by the same Cuckoo into the same nest. The

nests principally selected are those of the Hedge Sparrow, the Pied Wagtail, and the Meadow Pipit. The young Cuckoo, soon after it has been hatched, throws out of the nest the other young birds, and also the eggs, remaining sole occupant of the place, and securing to its own use the food which the old birds supply. This habit is the more remarkable in our common Cuckoo, as the American Yellow-billed Cuckoo, which has been occasionally taken in these countries, builds a nest and rears up the young in the ordinary way.



Fig. 272.—Woodpecker.

Poets have delighted in offering to the Cuckoo as herald of the spring their melodious tribute. Wordsworth refers to the well-known call of the male when the bird itself is concealed :—

"Thrice welcome darling of the spring!
Even yet thou art to me
No bird, but an invisible thing—
A voice, a mystery."

Its cheerful note, and the verdure with which in our minds it is associated, are alluded to, no less happily, by another writer :—

"Sweet bird! thy bower is ever green,
Thy sky is ever clear;
Thou hast no sorrow in thy song,
No winter in thy year."—Logan.

Tribe IV.—GAPING-BILLED BIRDS.—FISSIROSTRES.

"This guest of summer
The temple-haunting Martlet, does approve,
By his loved mansionry, that the heaven's breath
Smells wooingly here; no jutty, frieze, buttress,
Nor coigne of vantage, but this bird hath made
His pendant bed, and procreant cradle: where they
Most breed and haunt, I have observed the air
Is delicate."—Shakspeare.

The first family of the present group consists of the Bee Eaters (*Meropidæ*), birds of bright plumage, natives of Africa and of Asia Minor, which, as occasional visitors, are ranked among British species. Next to them the Kingfishers (*Halcyonidæ*, *Fig.* 273), claim our attention. There is but one native species (*Alcedo ispida*), and in point of brilliant plumage, it is unquestionably the first of British birds, and not surpassed by many of those belonging to tropical countries. It chooses for the site of its nest some spot in the overhanging bank of a stream, and lives upon small fish and aquatic insects. Kingfishers, like many other birds, possess the power of reproducing the contents of the stomach at pleasure.* This is of service at times in feeding the young, and on other occasions in discharging, as in the case of birds of prey, the indigestible portions of the food.



Fig. 273.—Kingfisher.

It was formerly believed that the Kingfisher, or, as it was then termed, the Halcyon, hatched her eggs in a floating nest, and that, during the time she was thus engaged, the winds

* Yarrell's British Birds, vol. ii., to which the reader is referred for information, drawn from various sources, respecting the fabled Halcyon.

were at rest, and the sea remained smooth and calm. This period was therefore called by Pliny and Aristotle the Halcyon days, and as such is frequently mentioned or referred to by the poets. Thus—

> ——————"All nature seemed
> Fond of tranquillity; the glassy sea
> Scarce rippled—the Halcyon slept upon the wave;
> The winds were all at rest."—THE STORM.

The Goatsuckers (*Caprimulgidæ*), to whose habits reference has already been made (p. 328), form another family of this tribe. Though abundant in certain situations they are not generally diffused; and about Belfast their occurrence is so very rare that we have never seen one alive. We shall therefore devote all our available space to the remaining family, that of the Swallows (*Hirundinidæ*).

"The Swallow," says Sir Humphrey Davy, in his Salmonia, "is one of my favourite birds, and a rival of the Nightingale, for he cheers my sense of seeing as much as the other does my sense of hearing. He is the glad prophet of the year—the harbinger of the best season; he lives a life of enjoyment amongst the loveliest forms of nature; winter is unknown to him; and he leaves the green meadows of England in autumn for the myrtle and orange groves of Italy, and for the palms of Africa." The bird does not winter in Italy;* but in other respects, "this is, in truth," to use the words of Mr. Yarrell, "a brief but a perfect sketch of the history of the Swallow."

The Swallow (*Hirundo rustica*) arrives in these countries about the 10th of April, and remains about six months. It builds in the shafts of unused chimneys, and under the shelter afforded by the roofs of out-houses, preferring such situations as are in the vicinity of water, and where its insect prey may be regarded as most abundant. The chesnut and blue of the breast, the black legs and toes, and the larger size distinguish it from the species next to be mentioned.

The House-martin (*H. urbica*).—In this bird the chin and all the under part of the body is white, and the legs covered with short downy white feathers. It appears a few days later than the Swallow. It is this species which the poet has so beautifully pictured (p. 344); and whose nest every one has

* "Swallows leaving Italy, which they all do in autumn, go off in the direction of Egypt, and have been seen in Egypt going still farther south." Yarrell, vol. ii.

seen fixed under the eaves of houses, and the upper angles of windows. They are sometimes placed under the arch of a bridge, and the magnificent headlands of basalt on the county of Antrim coast, are favourite haunts.

The House-martins return to their old abodes. Mr. Thompson records an instance in the neighbourhood of Belfast, in which a pair found their nest occupied by a Sparrow, who seemed determined to keep possession. The Martins departed, returned with about twenty of their kindred, and built up the entrance to the nest, inclosing the offender within. Next morning the pair of Martins commenced the construction of a new nest, against the side of their old one, and in it, undisturbed, reared their brood. After some time the proprietor of the cottage had the curiosity to pull down both nests, and in that occupied by the Sparrow found its "rotten corpse," together with several eggs. Mr. Thompson suggests that the Sparrow allowing herself to be entombed alive, may probably be explained on the supposition that the eggs were in the last state of incubation, as at such times birds will occasionally allow themselves to be lifted in the hand, and when placed again continue to sit as intent upon their hatching as if they had not been disturbed.*

The Sand-martin or Bank-martin (*H. riparia*) is smaller in size than either of those mentioned, and is the earliest to arrive in these countries. It has been seen in the neighbourhood of Belfast on the 29th of March. It forms excavations in sand-banks, and in these constructs its nest; from this habit the name is derived.

The Common Swift (*Cypselus murarius*) is distinguished by its greater expanse of wing, its darker colour, and by having all the four claws of its foot pointing forward, instead of three forward and one backward, as in the Swallow and the Martins. It prefers for its building-sites lofty towers and church steeples, but when these are not to be had, it very wisely contents itself with more lowly stations, such as the eaves or thatch of dwelling-houses. It also frequents the romantic precipices which are resorted to by the Martin.† It usually arrives the first week in May, and departs in August, though an occasional straggler may be seen after that period.

* Mag. Annals of Natural History. vol. x. p. 50. References are there given to other notices of similar events.

† Thompson.

Order III.—RASORES.—SCRAPING BIRDS.



Fig. 274.—Golden Pheasant.

The present order includes the common Barn-door fowl, such as the Cocks, Hens, Pea-fowl, and Turkeys; also the different kinds of Pigeons, Pheasants, Grouse, and Partridge. They are not in general adapted for rapid flight. They have the body bulky, the wings short, the legs robust, and the feet formed for walking;—the feet are also employed in scratching the ground, and thus exposing to view the seeds or other food on which the birds subsist. It is this habit of scraping or scratching the ground, that gives the name to the order, the Latin word *rasores* literally signifying "scrapers." Passing by those which are living in a domesticated state, the species known as native in these countries may be arranged in four families—Doves, Pheasants, Grouse, and Bustards.

Columbidæ.—To this family belongs the Ring-dove, or Wood-pigeon (*Columba palumbus*); it is the Cushat of the poets, and the Wood-quest of the North of Ireland. This species frequents woods, and in certain situations is so numerous that many hundreds may be seen in a single flock. Great are the complaints made by farmers of the injury they sustain by the quantity of grain consumed by these birds; and some who have advocated the utility of the Rooks have felt unable to do the same with regard to Wood-pigeons. Not so, however, Mr. St. John. An agricultural friend called his attention on the 6th of March, to an immense flock of these birds busily at work on a field of young clover, which had been under

barley the last season. "On this," says he, "in furtherance of my favourite axiom, that *every wild animal is of some service to us*, I determined to shoot some of the Wood-pigeons, that I might see what they actually were feeding on; for I did not at all fall into my friend's idea that they were grazing on his clover." Eight were accordingly shot as they flew over his head. On being opened, "every Pigeon's crop was as full as it could possibly be of the seeds of two of the worst weeds in the country, the wild mustard and the ragweed, which they had found remaining on the surface of the ground, these plants ripening and dropping their seeds before the corn is cut. Now, no amount of human labour and search could have collected, on the same ground, at that time of the year, as much of these seeds as was consumed by each of these five or six hundred Wood-pigeons daily, for two or three weeks together."*

The Rock-dove (*C. livia*) builds in rocky cliffs and caverns, most usually in the vicinity of the sea, but occasionally inland. It is the species from which the varieties of the domestic Pigeon are derived. We cannot here detail the means by which these are preserved and perpetuated; we prefer limiting our brief notice to one of these varieties, the Carrier-pigeon, a bird whose services have been made available not in love affairs only, but in those of the turf, the mart, the exchange, and the cabinet; in all the deep stakes which are won and lost in the chequered pursuits of human life.

From the rapidity and general certainty with which the letter entrusted to the Carrier-pigeon is conveyed, it would seem at first sight as though the bird were guided by some mysterious instinct; but our wonder is diminished when we are aware of the care and pains bestowed upon the training of these Pigeons. They soon learn, in their daily excursions with the old birds, to know their own abode, and to distinguish it from all others. They are then brought a short distance from home in a covered basket, and let loose. The distance is increased, until two, four, eight, ten, or twenty miles are gradually attained; and this is continued until the entire distance they are expected to perform has become familiar to them. When first let loose, the flight is spiral; when a sufficient elevation has been gained, and some well-known object descried, the bird goes off in a direct and unwavering line of flight.

* Wild Sports of the Highlands, p. 119.

If no unfavourable circumstances occur, such as fog, mist, or a strong opposing wind, the speed with which the journey is accomplished is very remarkable. Of this many well-authenticated instances are recorded. On one occasion a Carrier-pigeon flew from Rouen to Ghent, a distance of about 150 miles, in an hour and a half.* On another, 23 Irish miles were accomplished in eleven minutes; or, in other words, at the rate of 125½ miles an hour.†

The Turtle-dove (*C. turtur*) is a summer visitant, but by no means widely or plentifully diffused. The Passenger-pigeon (*C. migratoria*) is included, like other stragglers, in the list of British birds. It is a native of America, and ranges over the whole of the vast continent lying between the Rocky Mountains and the Atlantic. To the works of Wilson, Audubon, and other writers, we must refer for an account of its habits. We can but notice the amazing numbers in which it sometimes appears, and the quantity of food required for the daily sustenance of one of these immense flocks. Estimating its breadth at one mile, which is below the average, and allowing two Pigeons to each square yard, the number in one flock, according to Audubon, would be 1,115,000,000; and, as every Pigeon consumes daily half a pint of grain, the quantity required to feed such a flock must amount to 8,712,000 bushels per day.‡

Phasianidæ.—The common Pheasant (*Phasianus Colchicus*) represents another family. This beautiful bird has been long naturalized in these countries, but came originally from the banks of the Phasis, a river in Colchis, in Asia Minor. Its splendid congener the Golden Pheasant, is represented in *Fig.* 274. The Grouse belongs to another family (*Tetraonidæ*); one of these, the Red Grouse (*Tetrao Scoticus*), is peculiar to the British Islands, being unknown in any other part of the world. It inhabits wild extensive heaths, whether moor or mountain, and in some districts of both Scotland and Ireland is very abundant. The Black Grouse is found in both England and Scotland, but not in Ireland. This bird has been known to pair with the Pheasant in a wild state, the hybrids thus produced exhibiting some of the characters of both species. The White Grouse,

* Yarrell. † Thompson.

‡ Audubon's calculation is founded on the supposition that the flock, moving at the rate of one mile per minute, takes three hours to pass by a given spot; thus forming a parallelogram of 180 miles long, by 1 broad.

or Ptarmigan (*Lagopus mutus, Fig.* 275), is only found on some of the high mountains of Scotland and the adjacent islands. It is celebrated for its change of colour. The legs and toes are so thickly covered with woolly feathers, that they have been compared to the legs of a Hare.* In summer the plumage is speckled, consisting of an ashy brown, with waving blackish lines; as winter approaches, this becomes changed to the purest white. In the one season the plumage resembles in colour that of the surrounding rocks and lichens; in winter, that of the snowclad mountains. Sir Walter Scott attributes, therefore, acute powers of vision to Malcolm Græme, when he says:—



Fig. 275.—Ptarmigan.

> "Trained to the chase, his Eagle eye
> The Ptarmigan in snow could spy."
>
> Lady of the Lake.

The Common Partridge (*Perdix cinerea*) is another member of the same family; so that in this one group we have an assemblage of birds possessed of peculiar attractions to the "sportsman."

To the Quail (*Perdix coturnix*) a different kind of interest attaches. This bird is believed to be identical in species with that which, under the providence of God, furnished a supply of food to the Israelites in the wilderness. It abounds in countries adjacent to the Red Sea, and migrates in immense multitudes. Temminck says that they arrive in such numbers on the western shores of the kingdom of Naples, that so many as 100,000 are taken in a day. Nor are they less numerous on the shores of Provence. Above three thousand years have rolled by since the Quails "came up and covered the camp of

* Hence the generic name *Lagopus*, signifying a "Hare's foot."

the Israelites," yet the species still survives, and its gregarious and migratory character remains unchanged.

One of the Grouse tribe—the Capercaillie, or Cock of the Woods (*Tetrao urogallus*), formerly existed both in Britain and Ireland, but has, unhappily, been extirpated. This splendid bird attained the size of a Turkey, and by some writers is even spoken of as the Wild Turkey. Attempts for its re-establishment are now being made, and with prospects of success. It is found in Sweden and Norway, and other parts of the north of Europe.

Struthionidæ.—The Bustards are birds of rare occurrence. The Great Bustard (*Otis tarda*) has long been extinct in both Scotland and Ireland: in England it is spoken of rather as one which had recently "a local habitation," than as one actually indigenous at the present time. The Little Bustard (*Otis tetrax*) is an occasional visitant.

Order IV.—GRALLATORES.—WADING BIRDS.

"No more thy glassy brook reflects the day,
But, chok'd with sedges, works its weedy way;
Along thy glades, a solitary guest,
The hollow-sounding Bittern guards its nest;
Amidst thy desert walks the Lapwing flies,
And tires their echoes with unvaried cries."

Goldsmith's "Deserted Village."

There are some birds whose legs are so long that the body seems as if mounted on a pair of stilts, and this peculiarity is that which is expressed by the scientific name for the present order—*Grallatores*—a Latin word, literally meaning those who walk on stilts. The lower part of the leg is naked, and from this circumstance, as well as from its length, is especially adapted for wading. Hence, birds of the present order are called "Waders."

But although this term is very correct as applied to some, it is altogether incorrect with regard to others: thus, the Ostrich (*Fig.* 249), which lives remote from the sea, and from the banks of rivers, is included: and birds which, like the Plover, are not remarkable for great length of leg, are also

included. The fact is, that here, as in other great groups, the characteristics must be sought in some which may be looked upon as the types or representatives of the order, and not be rigorously required in every individual that naturalists may place in the same assemblage.

Cuvier arranges, in one family, all the birds of the present order whose wings are not adapted for flying, as those of the Ostrich (*Fig.* 249), and of the Cassowary (*Fig.* 238). Here, also, is placed the Apteryx (*Fig.* 276), the wingless bird of



Fig. 276.—Apteryx.

New Zealand. It is a creature so strange, that no imagination could have fancied a bird without wings or tail, with robust legs, claws suited for digging, and actually used in forming excavations in which this singular bird lays its eggs and hatches its young. When we add that its habits are nocturnal, we have stated the most striking peculiarities of a bird which is now rare, and may possibly become extinct. Dissection shows the existence of the wing-bones, but in a rudimentary state.* This entire division is without any representative among our native birds.

Charadriadæ.—The Plover is the true representative of this family, and derives its name from the French "*Pluvier*," a term given because the bird appears in large migrating flocks in the rainy weather of spring and autumn. The Golden Plover (*Charadrius pluvialis*) frequents swampy grounds and solitary bogs. It is one of those birds which appear to have a double moult. The real moult, or actual change of feathers, occurs in autumn; in spring some new feathers appear, and others undergo a change of colour; so that the aspect of the bird alters twice in the course of the year. The Golden Plover, and still more the species next mentioned, exhibit a

* Professor Owen on the Apteryx, Trans. Zool. Society.

great variety of devices to draw any intruder away from the vicinity of the nest or young; feigning lameness, or allowing a wing to droop as if it were broken, and thus tempting the inexperienced visitor to follow in the hope of taking the bird prisoner.

Besides different species of Plovers, this family contains the Lapwing or Peewit (*Vanellus cristatus*). To this bird the term "elegant" is peculiarly appropriate, from its figure, its crest, its plumage, and the ease and vivacity of every movement. The English name Lapwing is given because of the slow movement of its wings in flight. Its peculiar note has suggested the other name of Peewit. The French convey an idea of its cry by the words *dix-huit.** It gives life and interest to the wildest moor. The stratagems it employs for the safety of its young are well known, and are mentioned by every observer of its habits.

Gruidæ.—The common Crane (*Grus cinerea*, *Fig.* 277) is a very rare visitant in England; and in Ireland has been unknown for more than a century.† Mr. Gould says, "Flocks of the birds are seen at stated times in France and Germany, passing northwards and southwards, as the season may be, in marshalled order, high in the air, their sonorous voices distinctly heard, even from their elevated course." It is said to winter in Africa.



Fig. 277.—Crane.

Ardeidæ. — The common Heron (*Ardea cinerea*) is probably one of the best known birds belonging to the present order. Its motionless attitude as it watches for its prey in the shallow of the river or the sea, cannot fail to have attracted attention, adding, as it not unfrequently does, to the pictu-

* M. Edwards' Elémens, p. 121.

† Smith, in his History of Cork, states it was seen during the remarkable frost of 1739. Thompson's Report on the Irish Fauna.

resque effect of the scene. Nor less striking is its appearance on the wing, the long outstretched legs acting as a counterpoise to the head and neck. It is a singular spectacle to behold these birds collecting in spring at their building stations, occupying, like Rooks, the upper branches of high trees, and beginning once again the important business of incubation. They do not invariably choose such situations, but occasionally select precipitous rocks near the coast, as at the Great Orme's Head. On the Scotch coast, near Cromarty, Mr. St. John describes a heronry at which some of the nests were built in clusters of ivy, and others on the bare shelves of the rocks.* It seems strange, when possessed of ample power to range and choose at pleasure, that the same bird should select situations so very dissimilar.



Fig. 278.—Bittern.

The Common Bittern (*Botaurus stellaris, Fig.* 278) is no longer a common bird, and is every year, as waste lands are reclaimed, becoming more rare. During the breeding season it utters a loud booming or bellowing noise,† to which some of our poets have alluded.

> "But the Lark's shrill fife shall come
> At the day-break from the fallow,
> And the Bittern sound his drum,
> Booming from the sedgy shallow."
>
> Lady of the Lake.

Thomson, in his notice of the bird, has embodied an erroneous but current opinion, as to the manner in which the booming noise is produced:—

> ——————"So that scarce
> The Bittern knows his time, with bill ingulph'd,
> To shake the sounding marsh."—Spring.

Living remote from human haunts, on the marsh, the bog,

* Wild Sports of the Highlands, p. 123.

† This bellowing may have suggested the term *Botaurus*, meaning a Bull.

and the quagmire, it continues to this day the emblem of desolation and solitude, as it was at the time when the Prophet proclaimed against Babylon the awful denunciation: "I will also make it a possession for the Bittern, and pools of water; and I will sweep it with the besom of destruction, saith the LORD of hosts."

The Stork (*Ciconea alba*) is another member of the same family that must not be passed by without mention. Those who have travelled in Holland and other parts of the continent, know the favourable light in which it is regarded, and the arrangements made for its accommodation and protection. The affection of the Stork for its young, is one of the most remarkable traits in its character; it is only needful to refer to the female, which at the conflagration of Delft, after several unavailing attempts to remove her young, chose to remain and perish with them, rather than leave them to their fate. Among the ancient Egyptians the Stork was regarded with reverence inferior only to that which was paid to the Sacred Ibis (*Fig.* 279).* The Ibis itself is a member of the present family; one species, the Glossy Ibis (*Ibis falcinellus*), has been taken both in England and Ireland.



Fig. 279.—IBIS.

Scolopacidæ.—This family comprises the Curlews, Sandpipers, Snipes, and other well-known birds. It may be well represented by the Woodcock (*Scolopax rusticola*), a migratory species, ranging from Africa to Scandinavia. It flies by night, and seems in these countries to feed principally on the common Earthworm. The fact is now established, that all the Woodcocks do not leave these islands, but that a small, though gradually increasing number are permanently resident, and regularly lay their eggs and

* *Vide* Bennett's Gardens and Menageries, p. 20.

bring forth their young. This is mainly attributed to the shelter afforded by the increased extent of plantations.*

Rallidæ.—Of the Land and Water Rails, the best known individual is the male bird, whose peculiar yet not unpleasing "crake" is heard from our meadows in spring and the early part of summer, and has gained for the species the name of "Corn-crake." To the same family belong the active Water-hen (*Gallinula chloropus*) and the common Coot (*Fulica atra*). Respecting the habits of both of these, the Bishop of Norwich relates many pleasing particulars, to which we refer our readers,† as the space to which we are restricted forbids their introduction here. There is a marked difference in the foot of the two species. In the Water-hen the toes are long, and are fringed on each side by a narrow membrane. In the Coot the membrane is increased in size, assumes the form of rounded lobes, and unites the toes towards the base, thus indicating an approach to the complete webbed foot, which is characteristic of the swimming birds, which constitute the next order.

Order V.—NATATORES.—SWIMMING BIRDS.

"Some sought their food among the finny shoals,
Swift darting from the clouds, emerging soon
With slender captives glittering in their beaks."

Montgomery's "Pelican Island."

In the birds of this order the bill is variously shaped. The legs short; often placed far behind, adapted for swimming.‡ The feet—using that word in the ordinary sense—differ in form, and in the extent to which the toes are webbed; the part above the foot is much narrower in front than at the sides, and hence offers less resistance to the movement of the foot when the bird is swimming.

Here, as in other instances, a doubt may exist as to whether

* Full information on many points of interest in the habits of this bird, may be found in a paper by Mr. W. Thompson, Annals and Mag. Nat. Hist. January, 1839.

† Familiar History of British Birds, vol. ii.

‡ Jenyn's Manual.

a particular species should rank in the group under consideration, or in one to which it is allied by striking peculiarities of structure. In the Flamingo (*Fig.* 280) we have the long



Fig. 280.—Flamingo.

legs of the Waders combined with the webbed feet of the Swimmers; and, accordingly, a different place has been assigned to it by different naturalists, as they attributed a greater or less degree of importance to certain characters. Such points we pretend not to determine; we would rather mention that the generic name (*Phœnicopterus*) means, literally, "wings of flame;" and African travellers describe the appearance of the birds, when assembled in ranks, in a manner which bears out the accuracy of the picture presented by the poet:—

> "Flamingoes in their crimson tunics, stalk'd
> On stately legs, with far exploring eye;
> Or fed and slept in regimental lines,
> Watched by their sentinels, whose clarion-screams
> All in an instant woke the startled troop,
> That mounted like a glorious exhalation,
> And vanished through the welkin far away."
>
> Montgomery's "Pelican Island."

From the great extent of coast and the varied character of the British Islands, the birds of the present order are so numerous as to constitute more than one-fourth of the entire of the native species. They are arranged in five families, according to the form and structure of the bill, the wings, the toes, and the position of the legs.

Anatidæ.*—The first of these comprises Geese, Swans, Ducks, and allied species. Most of the Wild Geese are winter visitants to these countries; and the long strings in which they are seen to fly, changed at times into a wedge-shaped figure like that of the letter ≺, cannot be looked on without admiration.

The two best known species are the Bean Goose (*A. segetum*) and the White-fronted Goose (*A. albifrons*), and of these the Bean Goose is much the more common. These birds are remarkable for their watchfulness, not only at night, but during the time of feeding. Before alighting for this purpose on a field of new-sown grain, they make several circling flights, to see if all be safe, and then commence feeding. They take the precaution, however, to plant a sentry, who, as Mr. St. John informs us,† "either stands on some elevated part of the field, or walks slowly with the rest—never, however, venturing to pick up a single grain of corn, his whole energies being employed in watching. When the sentry thinks he has performed a fair share of duty, he gives the nearest bird to him a sharp peck. I have seen him sometimes pull out a handful of feathers if the first hint is not immediately attended to, at the same time uttering a querulous kind of cry. This bird then takes up the watch, with neck perfectly upright, and in due time makes some other bird relieve guard."

The Bernicle Goose (*A. bernicla*) and the Brent Goose (*A. brenta*) are regular winter visitors, and abound in certain localities. The Brent Goose is killed during the season in great numbers, being esteemed for table use. In Belfast Bay it is always called the "Barnacle."

The appearance and habits of the Swan are so well known, that it is needless to dwell upon them. There are, however, two species of Wild Swan which visit these countries in winter, and present some interesting peculiarities. If the skater, in the midst of his evolutions on the ice, should chance

* Latin, *Anas*, a Duck. This family is now subdivided.

† Wild Sports of the Highlands, p. 157.

to hear a loud hooping cry, and notice a flight of birds of large size, and of powerful pinions, passing over his head at a great elevation, he will not fail to remember the Hooper or Whistling Swan (*Cygnus ferus*). In entire contradistinction to this species, the one which is domesticated is termed the Mute Swan (*C. olor*); yet it is respecting this bird that the fable became current, that it foretold its own death, and sung with peculiar sweetness at its approach. Thus Shakspeare:—

> ——"I will play the Swan,
> And die in music."

But, although the voice of the Swan is but little noticed, the bird is not really mute, as its name would imply; the notes are soft and low, and are described as "plaintive, and with little variety, but not disagreeable."* The classical scholar will call to mind the well-known line, in which the existence of a Black Swan is spoken of in a manner which implies the utter disbelief in the existence of such a bird; yet, among the strange creatures which New Holland has sent to us, are Black Swans; these are now distributed over many parts of these kingdoms where aquatic menageries are established, and form, by their dusty hue, a striking contrast to the snowy tint of their congeners.



Fig. 281.—Eider Duck.

The Sheldrake, the various species of Wild Ducks, with the Teal and Widgeon, we must pass by. The Eider Duck (*Somateria mollissima*, *Fig.* 281) deserves especial notice, as

* Yarrell.

it supplies the valuable eider-down of commerce. The bird is a very rare visitant to the Irish coast, but is permanently resident in some places on the northern shores of Britain. Its great haunts, however, are the coasts of Norway, Lapland, Iceland, and other localities still farther north. The down is plucked by the female from her breast, and spread over the eggs. The fowlers, to whom the districts frequented by the Eider Duck become a valuable property, carry off both eggs and down, the eggs being used by them as food. The Duck again lays, and her nest in like manner is again despoiled. She lays a third time, the male supplying such of the down as she can no longer furnish, and she is then allowed to rear her young without molestation.

Colymbidæ.—The Grebes and the Divers constitute the present family; and a glance at the annexed figure of the



Fig. 283.—Great Northern Diver.

Great Northern Diver (*Colymbus glacialis*, *Fig.* 282), will convey a better idea of the different aspect of the members of this and the preceding group, than any description. The Divers, as their name implies, are remarkable for their diving powers, thus pursuing their prey and evading their enemies. The bird figured belongs to a species which may be said to live upon the water, except during the time devoted to the rearing of the young. It is a winter visitant to both the British and Irish

coasts, and has occasionally been met with in summer. Like the Gannet, it is sometimes entangled in the nets of the fisherman; and Mr. W. Thompson has related to us one instance in which a Diver, when thus taken, was found to have swallowed a hook, having doubtless been attracted by the tempting appearance of the fish-bait.

Alcidæ.—The Guillemots resemble in many respects the Divers. We pass them by to notice the Puffin (*Alca arctica*), a bird common round our coasts during the summer months. Its most striking peculiarity is the bill, which has gained for it the titles of "Sea-parrot," and "Coulter-neb." To this family belongs the Penguin (*Fig.* 283), whose singular plumage has been already noticed (*ante*, p. 287). The wings, so powerless for flight, are, however, most efficient as fins. When at sea and fishing, it comes to the surface, for the purpose of breathing, with such a spring, and dives again so instantaneously, that no one could at first sight be sure it was not a fish leaping for sport.* The Penguin is not deficient in courage. At one of the Falkland Islands, Mr. Darwin placed himself between one of these birds (*Aptinodytes demersa*) and the water. "It was," says he, "a brave bird; and till reaching the sea, it regularly fought and drove me backwards."† Similar intrepidity was evinced by some Penguins met with by Captain Ross in the late Antarctic expedition. The birds, from their great size, were named the "king" and the "emperor," for there were two species. But both, however, evinced equal hardihood, and showed their determination to do battle for their land of nativity, even when opposed to British seamen.



Fig. 283.—Penguin.

Pelecanidæ.—The name of this family implies that it may be represented by the Pelican. We have but three native species, of which the most common is the Solan Goose (*ante*, p. 291). The other two belong to one genus, and are known

* Darwin's Journal, p. 257. † Idem, p. 256.

to every one by character, if not by appearance; for to eat like a Cormorant has become almost the simplest mode of expressing great voracity. The common Cormorant (*Phalacrocorax carbo*), when gorged with food, is to human eyes so unattractive that it is under this form Milton describes Satan, after he had gained admission into Paradise—

> ——"Up he flew, and on the tree of life
> Sat like a Cormorant—devising death
> To them that lived."

The Chinese employ the Cormorant in fishing. A ring is placed round the neck of the bird to prevent the prey being swallowed, and as soon as a sufficient number has been obtained for its master the ring is removed, and the bird allowed to fish on its own account.

Laridæ.—The Terns, Gulls, and Petrels belong to the present family. The Terns are also called Sea-swallows,* a term expressive of ease and rapidity of flight, and of some resemblance in other respects, among which the long-forked tail is perhaps the most striking (*Fig.* 284). They live upon small



Fig. 284.—Tern.

fish, and flying some yards above the water, dart down with such quickness and precision as rarely to miss the object of their aim.

The Gulls are, however, better known than either of the other tribes. The mariner finds them in all seas; and the landsman who visits the coast cannot fail to remark their grace-

* *Hirondelles de mer* of the French authors.

ful flight, the buoyant ease with which they ride upon the waves, and the animation which they give to the scene. Perhaps few ordinary occurrences are more striking than what is termed a "play of gulls;" when the birds, having discovered a shoal of young fish, are swimming among them, hovering over them, uttering wild screams of joy, plunging down into the midst of the shoal, and gorging their prey with riotous delight. This, however, is not their only food. The carrion and the offal of the beach are not less acceptable; and two of our largest native species* attack wounded birds, and will even carry them off, before the shooter by whom they have been struck, can reach the spot. "When," says Mr. St. John, "I have winged a duck, and it has escaped and gone out to sea, I have frequently seen it attacked and devoured almost alive by these birds."†

Their voracious appetite occasionally brings them into peril. Thus the Kittiwake and other Gulls are taken at Ballantrae, in Ayrshire, by hooks baited with the liver of the cod-fish, and are sold for the sake of their feathers. In other localities the Gulls seek to diversify their fare in spring-time by visiting the fields, and picking up the grubs and worms which the plough brings to the surface; and at Horn-head, in the county Donegal, the Herring Gull (*L. argentatus*) is said to destroy young rabbits.‡

The precipitous cliffs, and the low lying ledges of rocks, on which the various species of Gulls build their nests and bring forth their young, are, in many respects, interesting objects for contemplation. At first sight all seems confusion, and the nests indiscriminately mingled; but a little further examination shows that order prevails amid the apparent disorder, and that each kind of Gull apparently gives a preference to a certain situation. But these are not their only breeding haunts; the little island in a retired mountain lake, and other island localities of a similar kind, are favourite places of resort. In Norfolk, at a distance of thirty miles from the sea, thousands of the Black-headed or Red-legged Gull (*L. ridibundus*, *Fig.*

* The Great Black-backed (*Larus marinus*), and the Herring Gull (*L. argentatus*).

† Wild Sports of the Highlands, p. 216.

‡ The principal points of information in this paragraph are derived from the MS. Notes of Mr. W. Thompson, which have been most kindly placed at our disposal.

285) annually take possession of an island about thirty acres in extent, and build their nests.* In Ireland, the Black-headed Gulls frequent, for the same purpose, the gravelly beach of a portion of Ram's Island in Lough Neagh; and so closely are the nests placed over the ground, that Mr. W. Thompson



Fig. 285.—Black-headed Gull.

informs us, that he and some friends, when visiting the place, had to use great circumspection in putting down their feet, that they might not do injury to the nests or eggs. This species, as stated by the gentleman just mentioned, is that which is most abundant in Belfast Bay, and not the one to which the name of "Common Gull" (*L. canus*) is applied. Their evolutions are extremely varied and beautiful, exhibiting both power of wing and grace of movement.

Of the Petrels, the best known species is that which is the smallest of British web-footed birds, the Stormy Petrel (*Thalassidroma pelagica*). They crowd round vessels before and during stormy weather, partly for the sake, it is supposed, of shelter, and partly for that of food. Sailors regard them with superstitious feelings, and have long given them the name of "Mother Carey's Chickens," from some hag of the olden time, whose name would have passed into oblivion had it not been

* Bishop of Norwich's Familiar History of Birds, vol. ii. p. 246.

associated with those harmless little birds. Their dusky plumage, diminutive size, their habit of running upon the surface of the water, and the circumstances under which the mariner sees them, account very naturally for the feelings with which he regards them. Very differently are they viewed at St. Kilda, one of the northern islands of Scotland. There the birds are regarded as benefactors, giving the means of light throughout the long nights of winter; for so full of oil is the body, that a wick passed through it will burn as if fed from the oil-reservoir of a lamp. The usual practice of the inhabitants, however, is to collect the oil by itself. Mr. John Macgillivray, who visited the Hebrides in 1840, states,* "the bird sits very close upon the nest, from which it will allow itself to be taken by the hand, vomiting on being handled a quantity of pure oil, which is carefully preserved by the fowlers, and the bird allowed to escape." A larger species, the Fulmar Petrel (*Procellaria glacialis*) is even more valuable to the inhabitants of St. Kilda. "This bird," says Mr. J. Macgillivray, "exists here in almost incredible numbers, and to the natives is by far the most important of the productions of the island. It forms one of the principal means of support to the inhabitants, who daily risk their lives in its pursuit. The old birds, on being seized, instantly vomit a quantity of clear and amber-coloured oil, which imparts to the whole bird, its nest and young, and even to the rock which it frequents, a peculiar and very disagreeable odour." Within the last few years only, according to Mr. W. Thompson, has the Fulmar been known to visit the Irish coast. The Stormy Petrel, on the contrary, is at all times to be met with on the western shores, and breeds on several of the islands which are washed by the Atlantic.† Mr. George C. Hyndman, who visited Tory Island, off the north coast of the County Donegal, found the Stormy Petrel living comfortably in the Rabbit burrows, and there bringing out its young. After the hurricane of the 7th of January, 1839, Petrels were found not only in the central parts of Ireland, but even in the extreme east, having been driven across the island by the violence of the gale,‡

* Edinburgh New Phil. Journal.

† W. Thompson's Report on the Fauna, 1840.

‡ W. Thompson, Note on the Effects of the Hurricane on the Lower Animals. Annals of Natural History.

Mr. Darwin, in speaking of another species (*Puffinus cinercus*), which is common to Cape Horn and the Coast of Peru, as well as to Europe, remarks, "I do not think I ever saw so many birds of any other sort together, as I once saw of these behind the Island of Chiloe (off the west coast of Patagonia); hundreds of thousands flew in an irregular line for several hours in one direction. When part of the flock settled on the water, the surface was blackened, and a noise proceeded from them as of human beings talking in the distance. At this time the water was in parts coloured by clouds of small crustacea."*

Of the multitude of birds of one species that occasionally assemble together, examples have been given in the Starling (p. 336), the Passenger Pigeon (p. 349), and the Quail (p. 350); we have here another instance of the same remarkable fact, the birds themselves belonging to a different order, inhabiting a different region, and seeking their appointed food on the sea instead of the land.

If we turn from the birds now living, to the consideration of those that are extinct, we find their remains are much less numerous than those of fishes, reptiles, or quadrupeds. "Their powers of flight," as Mr. Lyell remarks, "insure them against perishing by numerous casualties to which quadrupeds are exposed during floods; and, if they chance to be drowned, or die when swimming on the water, it will scarcely ever happen that they will be submerged so as to be preserved in a sedimentary deposit."† This is easily accounted for when we consider, that, from the tubular structure of the bones, and the quantity of feathers, their bodies are extremely buoyant, and most generally float on the surface of the water until they rot away or are devoured. Yet, among the fossils of the London clay, and of the Paris basin, are those of several birds, specifically different from any that now exist.

There is one species recently extinct, but known by the descriptions of navigators about two centuries ago, by parts of the body preserved in different collections, and by paintings in the British Museum and elsewhere. It was called the *Dodo*, and was a native of the Mauritius. Its figure was massive; its weight, perhaps, forty-five or fifty pounds, and its wings so short as to be useless for flight. Much difference of opinion

* Journal. † Principles of Geology, vol. iii.

has existed among naturalists as to the tribe of birds to which the Dodo should be referred. From the bulky figure some thought it resembled the Turkey; while, from its hooked bill, it was thought by others to have belonged to the birds of prey. A recent examination of the bones composing the skull and foot, now in the Ashmolean Museum, in Oxford, has, however, proved that it is allied to the Pigeons, a tribe with which it was not supposed to have had any connection. Other birds allied in character to the Dodo inhabited the neighbouring islands of Bourbon and Rodriguez, all of which appear to have been sought for with uncalculating eagerness by the early colonists, and thus were speedily extirpated.*

We have mentioned (p. 257) that a gigantic reptile had left its foot-prints on the moist beach of the ancient sea. Similar testimony has made known the existence in former times of birds which have left no other trace behind. These foot-prints have been noticed in England, but more abundantly, and of larger size, in America, suggesting the idea of birds possessed of dimensions far beyond those attained by any living species. The impress of the human footstep on the beach of that island which Robinson Crusoe believed to be his own solitary domain, was scarcely more startling. Yet here, as in other instances, the marvel of the truth surpassed that of the conjecture.

Numerous bones were transmitted from New Zealand to England, which, on examination by Professor Owen, were found to belong to wingless birds of nine different species,† some of them of gigantic size. They were referred by him to the same genus, under the name *Dinornis*.‡

The annexed outline (*Fig.* 286) exhibits the figure of one of these birds, and that of a man, the relative proportions of both being preserved; it thus furnishes an easy mode of estimating their comparative dimensions.

The number of wingless birds, and the vast stature of some of the species peculiar to New Zealand, have suggested the idea, that the present island may be but the remnant of a larger tract or continent, over which they formerly ranged.

* Natural History and Osteology of the Dodo, Solitaire, and other extinct birds, by H. E. Strickland, Esq., and Dr. Melville.

† Professor Owen's Memoirs on the genus *Dinornis*. Transactions of the Zoological Society, parts 3 and 4, vol. iii.

‡ Literally, "enormously large bird."

"One might almost be disposed," says Professor Owen, "to regard New Zealand as one end of a mighty wave of the unstable and ever-shifting crust of the earth, of which the opposite end, after having been long submerged, has again risen with its accumulated deposits in North America, showing us, in the Connecticut sandstones, the foot-prints of the gigantic birds which trod its surface before it sank; and to surmise that the intermediate body of the land-wave, along which the *Dinornis* may have travelled to New Zealand, has progressively subsided, and now lies beneath the Pacific Ocean."*



Fig. 286.—DINORNIS †

* Memoir on *Dinornis*, part 4, vol. iii. p. 328.

† This outline is copied, with the kind permission of Professor Ansted, from his Picturesque Sketches of Creation; a highly attractive and interesting volume.—VAN VOORST.

CLASS IV.

MAMMALIA.

We have now reached the class which ranks as the highest of the animal kingdom; and to which man himself belongs. Here only do we find organs especially adapted for supplying to the young, during the prolonged period of helpless infancy, that fluid nutriment, to which we give the name of milk. This organization is so characteristic, that from the Latin word *mammæ*, signifying paps or teats, is derived the term *mammalia*, the scientific appellation by which the class is distinguished. Every animal that suckles its young may, from that circumstance, be referred to the present class.

Circulation.—The blood is warm, and the heart, as in birds, consists of four compartments. The general arrangement of the arteries through which the aërated blood in man is propelled, is shown in the annexed figure (287) which may be compared with *Fig.* 241, exhibiting the arterial system in the preceding class.

"Neither the circulation nor the respiration are quite so active, nor is the animal heat quite so great as in the class of birds."*

Respiration.—All the mammalia breathe by lungs. These are not attached to the ribs as in birds, but are suspended in a cavity at the upper portion of the trunk (*thorax*). They are divided into a multitude of minute cells into which air is conveyed by the branches of the windpipe. In the annexed

* Owen.

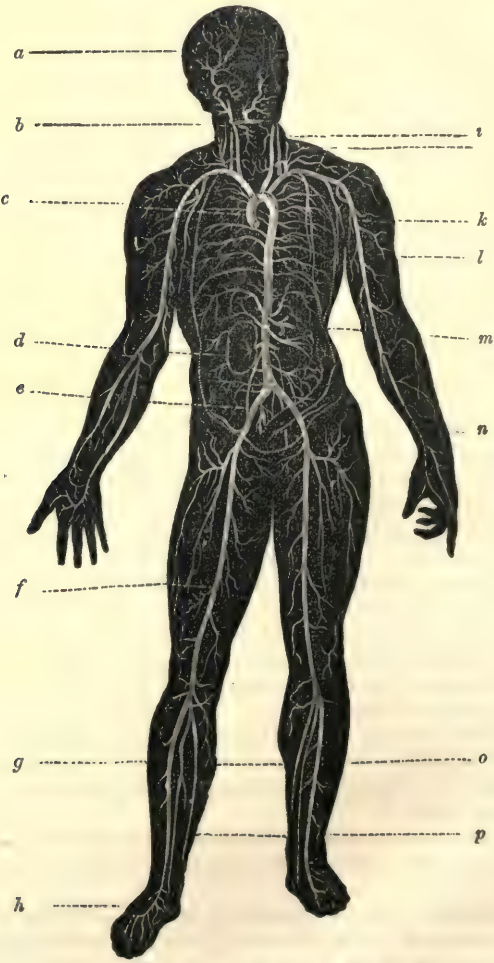


Fig. 287.—Arterial System of Man.*

* Fig. 287.—Arterial System of Man.—*a*, temporal artery; *b*, carotid artery; *c*, aorta; *d*, renal artery; *e*, iliac artery; *f*, femoral artery; *g*, anterior tibial artery; *h*, artery of foot; *i*, vertebral artery; *j*, subclavian artery; *k*, axillary artery; *l*, brachial artery; *m*, cœliac artery; *n*, radial artery; *o*, posterior tibial artery; *p*, peroneal artery.

representation (*Fig.* 288) these air-tubes are shown at one side, and the lung in its natural condition on the other. The reader is thus furnished with the means of comparing these important organs in man, with those which have been already exhibited (*Fig.* 242) as existing in birds.

Covering.—While scales form the characteristic covering of fishes, and feathers of birds, hair may be said to be that of the mammalia. It is not invariably present, and it undergoes many modifications in its appearance. We term it wool upon the sheep; the same material becomes spines upon the Hedgehog, and "quills upon the fretful porcupine" (*Fig.* 289). It even assumes an aspect still more extraordinary, and is converted into bony plates in the

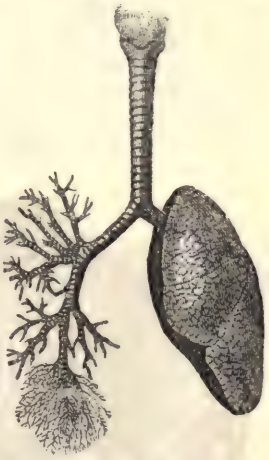


Fig. 288.—Air-Tubes, and Lungs of Man.



Fig. 289.—Porcupine.

defensive covering of the Armadillo (*Fig.* 311).

Skeleton.—By far the greater number of the animals belonging to this class move on the ground by the action of four feet, from which circumstance the name *quadruped* has been restricted to them. It is occasionally used in a more general sense, as synonymous with the scientific term *mammalia*. The outline of the skeleton conveys, in most cases, an idea of that of the body; but occasionally, as in the hump of the Camel (*Fig.* 290), there exists in the living animals

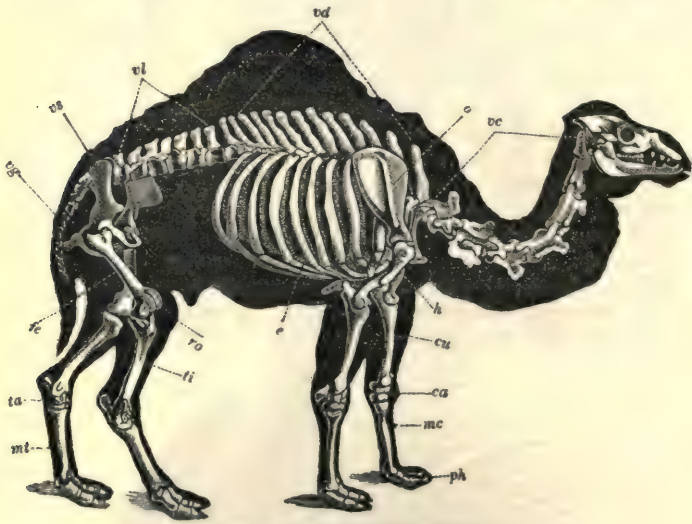


Fig. 290.—Skeleton of Camel.*

some peculiarly striking feature, which is not represented in the bony framework. The hump, in the present instance, consists of fatty tissue, and is well known to diminish in size, and nearly to disappear when the animal is exposed to long-continued privation.

The possession of four feet used for the purposes of locomotion, though general in the mammalia, is by no means

* Fig. 290.—Skeleton of the Camel on a black ground, exhibiting an outline of the animal; *vc*, cervical vertebræ; *vd*, dorsal vertebræ; *vl*, lumbar vertebræ; *vs*, sacral vertebræ; *vg*, caudal vertebræ; *e*, ribs; *o*, scapula; *h*, humerus; *cu*, bone of forearm; *ca*, carpus; *mc*, metacarpus; *ph*, phalanges; *fe*, femur; *ro*, patella; *ti*, tibia; *ta*, tarsus; *mt*, metatarsus. In *fig.* 291, the corresponding parts are indicated by the same letters as in *fig.* 290.

universal. In the true Monkeys, all the extremities are shaped like hands, and are used for prehension as well as for locomotion. In the Bats, that part of the anterior extremities which corresponds to the fingers of the human hand, is enormously developed, and forms the bony framework of the wings (*Fig.* 334). In the Seals (*Fig.* 291), the extremities are converted into paddles; and there are some warm-blooded herbivorous animals inhabiting the sea, in which the hinder legs are altogether wanting.

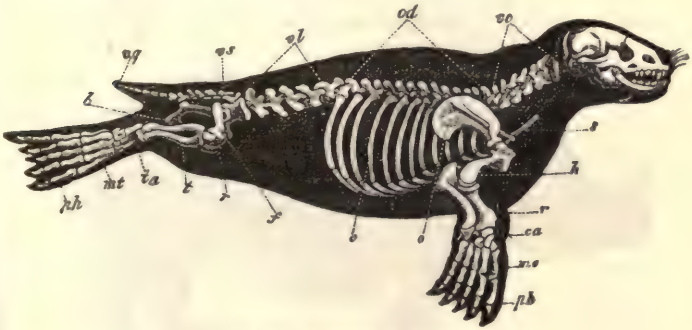


Fig. 291.—Skeleton of Seal.*

The number of vertebræ or joints in the spinal column varies much in the several tribes, the difference depending principally upon the presence or absence of the tail, and the varying number of its parts. A remarkable uniformity prevails in the structure of the neck. The short thick neck of the Elephant, and the long slender neck of the Giraffe, contain precisely the same number of vertebræ, namely, seven. This is the invariable number, though there are a few apparent exceptions. The mammalia present in this respect a singular contrast to birds (*ante*, p. 282), and show how in the mechanism of the animal frame, similar results may be attained by the most opposite arrangements.

Head.—The head differs greatly, not only in size and form, but also in what may be regarded as its appendages. The Tapir, an animal allied in many respects to the Hog, has the snout prolonged into a fleshy proboscis (*Fig.* 292), which is

* For description, *vide* foot-note, p. 372.

capable of extension or contraction, but does not act as an instrument of prehension. The Elephant, on the contrary (*Fig.* 322), is furnished with an organ remarkable for its varied powers of action, combining in the highest degree delicacy and strength. In both these instances the proboscis is a prolongation of the muscular fibre and covering, and not a distinct appendage. The Rhinoceros (*Fig.* 293) has a weapon which is found adhering to the skin, not growing



Fig. 292.—Head of Tapir.

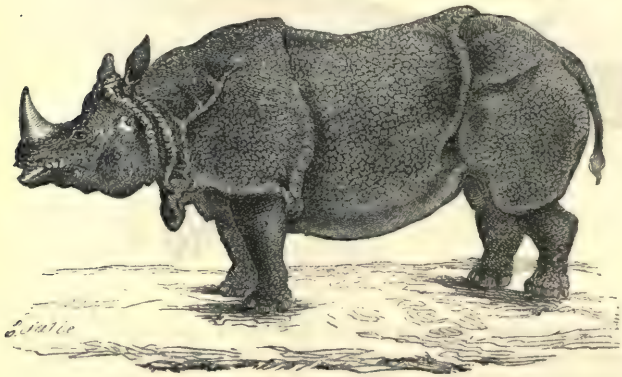


Fig. 293.—Rhinoceros.

from the skull; it is regarded as hair growing in a mass, and presenting the appearance of a solid horn. The Giraffe has bony protuberances, the rudimental representatives of the curved or branching horns with which other tribes of ruminating animals are furnished. In the Stag the horns have at first a hairy skin; when this has worn away and the horns have remained bare for a time, they are thrown off, and their place is supplied by others. In structure they resemble solid bone,



Fig. 294.—Head of Reindeer.

from which circumstance the animals of the Deer tribe are termed *Solid-horned Ruminants*. The quantity of bony matter thus annually secreted is very remarkable. In the large extinct species, popularly known as the "Irish Elk," the Antlers weighed from 60 to 70 lbs. and as in the existing males, were the growth of a single year. In the Ox and the Goat (*Fig.* 295), these organs are formed of the elastic substance which we call *horn*, and which is analogous to that of the hair and hoofs. They are hollow within, cover the bony axis like a sheath, and "continue to grow throughout life, but only at intervals, depending upon the season of the year, the age of the individual, and the supply of food."* To these animals the name of *Hollow-horned Ruminants* has been applied; the bony core of the horns is formed of cells, which communicate with the nose, and are thus filled with air. By this arrangement lightness is added to strength.

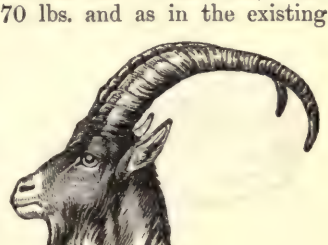


Fig. 295.—Head of Goat.

The tusks of the Elephant, though appendages exterior to the head, are in reality a part of the dental system of the animal, and are the representatives of those teeth which in man are known as the cutting or *incisors*. "They not only surpass all other teeth in size, as belonging to a quadruped so enormous, but they are the largest of all teeth in proportion to the size of the body."† Tusks of the Mammoth, an extinct species of Elephant, have been found from nine to eleven feet in length, and one has been known to weigh so much as one hundred and sixty pounds. The importance of these tusks as an article of commerce may be estimated from the fact, that in 1737, an account was published of the Mammoth's bones and teeth found in Siberia; and of the uses to which the tusks were applied; and "from that time to the present there has been no intermission of the supply of ivory furnished by the tusks of the extinct Elephants of a former world."‡

* Ogilby. Monograph of the Hollow-horned Ruminants. Transactions of the Zoological Society of London.

† Owen's Odontography. ‡ Idem.

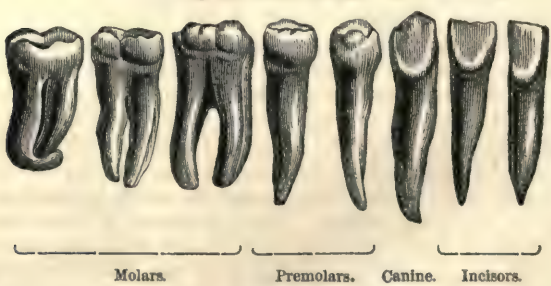
Another appendage to the head, and of great value in a commercial point of view, is that which is popularly, though not very correctly, termed "whale-bone." It is not bone, but a series of horny plates, the substitutes of the true teeth, which in the whale are altogether wanting. The position of these plates is shown in the annexed figure (*Fig.* 296); they form a complete fringe suspended from the margin of the upper jaw, and when the whale closes its enormous mouth, they act as a seive, permitting the water to pass through, and enabling the animal to retain the small gelatinous and molluscous creatures on which it lives. The "Baleen" or Whale-bone, is so important an article of trade, that hundreds of tons are annually brought into Britain, won by her intrepid mariners among the perils of the Arctic seas.



Fig. 296.—Skull of Whale.

Teeth.—We now pass on to the teeth, viewed as instruments for the mastication of food. In man they are thirty-two in number, when the series is complete; and the number is the same both in the Orang and Chimpanzee.* They are of three

Fig. 297.—Teeth of Man.



kinds, the *incisor* or cutting teeth, the *canine*, which attain a large development in the Dog and carnivorous animals, and hence derive their name;† and the *molar* or grinding teeth.

* Owen's Odontography.

† Latin, *canis*, a dog.

There are eight on each side of the upper, and also of the lower jaw; thus amounting in all to thirty-two.*

A few species of mammalia, as the Ant-eaters, are entirely devoid of teeth; in others there is a great diversity as to their number. The female Narwhal has two teeth, and both are concealed in the substance of the jaw. The Australian Water-rats have twelve. Most gnawing animals have twenty; but the Hares and Rabbits have twenty-eight. The Porpoise has between eighty and ninety, and the true Dolphins from one hundred to one hundred and ninety.†

It is found that the arrangement of the teeth varies, according as the food is to consist of animal or vegetable substances, of soft flesh or horny covered insects; of tender herbs, or wood of greater or less degree of hardness. Hence it is possible, merely by an inspection of the teeth, to determine, with considerable certainty, the diet, the habits, and even the general structure of most of the mammalia.‡

We never meet in nature with an incongruous union of parts. A Lion with the hoof of a Horse, could not subsist;



Fig. 298.—Skull of a Gnawing Animal.



Fig. 299.—Skull of a Boar.

it would die of hunger from inability to seize and retain its prey. In like manner, a Horse, with the teeth of a Lion, would starve in the midst of the finest pastures, from being unable to crop and triturate its food.

* Zoologists have adopted a formula for expressing the number of teeth possessed by different animals at each side of the mouth, distinguishing those in the upper jaw from those in the lower jaw. The dental formula of man is written thus:—

$$\text{Incisors}\frac{2-2}{2-2};\ \text{Canines}\frac{1-1}{1-1};\ \text{Premolars}\frac{2-2}{2-2};\ \text{Molars}\frac{3-3}{3-3};\ = 32.$$

† Owen's Odontography.

‡ M. Edwards' Elémens.

Bearing these facts in mind, let any one but look at the representations here given of the skulls and teeth of three of the most common quadrupeds, and he will at once be struck with the diversity of form and arrangements they exhibit, and the modifications of internal structure they indicate.



Fig. 300.—Skull of a Horse.

We are desirous, even at the risk of some repetition, that this matter should be clearly understood. The researches of the zoologist and the comparative anatomist, have proved the perfect dependence of one part of the animal form upon another. To this there is no exception; all living beings testify the same truth, and establish the unity of plan evinced by their organization. The geologist, in bringing to light the remains of the animals that in former ages were monarchs of the earth, adduces, amid all their diversity of form, no example that is not in accordance with the same great truth.

Hence, it is obvious that if there are structural laws, to which all are subject, the comparative anatomist may from portions of the frame infer the size, the structure, and the functions of all the rest, and describe the conditions under which the animal had lived.

To the genius of Cuvier we are indebted for pointing out this mode of investigation, and showing the important results to which it leads. The path which he thus opened has been successfully explored, and has revealed much that was previously unknown. It has brought to light forms and proportions too strange for Fancy to imagine, but not for Science to delineate. The fossil bone has in the hands of the zoologist become instinct with life, and told the tale of its existence. It has furnished him with a spell more potent than the "open sesame" of the eastern tale, and unlocked the portals within which the history of a former world lay recorded.

The necessary dependence of one part of the animal frame

upon another, is a principle that should ever be kept in view, and with which the mind of the learner should become familiar. We have seen, that, according to the nature of the food, there is an adaptation of parts both internal and external; these are accompanied by corresponding habits. Hence the organs needful for the providing of food—or in other words, the teeth and the extremities—furnish, so far as external characters are concerned, a sound basis for classification; and as such they were regarded by Cuvier.

While, however, the system laid down by that distinguished naturalist, in the last edition of his *Règne Animal*, is here adopted, it is not implicitly followed in every particular. Since the publication of that work, vast accessions to our knowledge of animals have been received, and impose the necessity of some changes in the classification. It would be contrary to the spirit of Cuvier not to concede what is thus demanded.*

The following distribution of the inferior animals into ten orders, is that which is sanctioned by the writings of two British naturalists, whose opinion on such matters is entitled to the highest respect.† Man is also included under the distinctive term applied to that of which he is the sole representative, thus making eleven orders in all.

I. Bimana	(*two-handed*)	Man.
II. Quadrumana	(*four-handed*)	Monkeys.
III. Cheiroptera	(*finger-winged*)	Bats.
IV. Insectivora	(*insect-eating*)	Hedgehog, Shrew.
V. Carnivora	(*flesh-eating*)	Lion, Tiger, Bear.
VI. Cetacea	(*whale-like*)	Whale, Porpoise.
VII. Pachydermata	(*thick-skinned*)	Elephant, Rhinoceros.
VIII. Ruminantia	(*ruminating*)	Ox, Deer.
IX. Edentata	(*toothless*)	Sloth, Ant-eater.
X. Rodentia	(*gnawing*	Rat, Hare, Squirrel.
XI. Marsupiata	(*pouched*)	Opossum, Kangaroo.

It is quite impossible in any linear arrangement such as the

* The principal change is the separation of the Bats (*Cheiroptera*) and the Hedgehogs, &c. (*Insectivora*), from Cuvier's order of "*Carnassiers*," or flesh-eating animals, and the elevation of those groups from the ranks of *Families* to that of distinct *Orders*. There are also changes with regard to the Marsupial animals.

† Professor Owen, in Cyclopædia of Anatomy and Physiology; and G. R. Waterhouse, Esq., in Magazine and Annals of Natural History.

above, where the several orders follow each in regular succession, to convey an idea of the affinities which sometimes connect families that belong to orders widely separated in the scale. The same difficulty presents itself in every extensive assemblage of animals, showing, as has already been remarked (p. 28), that "the chain of beings of which the poet has sung, has no real existence in nature."

The number of animals belonging to the class mammalia, has been variously estimated, from 1149 to 1500; the latter number is that adopted by the learned authors of the "Physical Atlas," as the basis of their calculations respecting the proportionate number of the species. The species described as British,* amount to between eighty and ninety, and those recorded as Irish, to little more than one-third of that number.†

In the limited space to which we are restricted, we shall not attempt to introduce those anecdotes illustrative of the habits of the Elephant, the Tiger, the Reindeer, &c., which are scattered throughout elementary works in general use. Our object shall rather be to point out how the different orders are characterized, and in what manner they are distributed.

With the laws affecting their geographical distribution, we are as yet but imperfectly acquainted. One of the most obvious causes which limit the growth of vegetables, and the range of animals within certain bounds, is temperature. Heat and moisture stimulate the growth of plants, and wherever vegetation is most luxuriant, there the land animals are most abundant. They are confined within certain limits by the intervention of seas and of continuous ranges of mountains. But even when such obstacles do not exist, animals appear subject to certain climatic conditions, and pass not the limits which the Author of the Universe has fixed as the bounds of their habitation. Thus in North America, Sir Charles Lyell observes there are "several distinct zones of indigenous mammalia, extending east and west on the continent, where there are no great natural boundaries running in the same direction, such as mountain ridges, deserts, or wide arms of the sea, to check the migration of species. The climate alone has been sufficient to limit their range. The mammiferous fauna of New York, comprising about forty species, is distinct from that of

* Professor Bell's British Quadrupeds.

† Thompson's Report on the Fauna of Ireland.

the arctic region, six hundred miles north of it, and described by Dr. (now Sir John) Richardson. It is equally distinct from that of South Carolina and Georgia, a territory about as far distant to the south."*

Our notice of the several orders of mammalia shall be commenced with those which are lowest in the scale, and gradually ascend to man, gifted as he has been with dominion "over every living thing that moveth upon the earth."

Order MARSUPIATA.—MARSUPIAL or POUCHED ANIMALS.

"Deform'd, unfinish'd, sent before my time
Into this breathing world, scarce half made up."—Richard III.

The greater number of the mammalia are nourished prior to birth, by a network of blood-vessels named the *placenta*.† This is altogether wanting in the group now under consideration. While others do not come into the world until they are provided with all their organs, these are brought forth in an extremely imperfect state. The female in most instances is furnished with a peculiar pouch (Latin, *marsupium*, a purse or bag), whence the scientific name for the order. In this pouch the immature young are received and nourished, and to it they afterwards retreat on the approach of danger. Certain bony projections, termed the Marsupial bones, are found in both sexes, even in those species in which the characteristic pouch does not exist.

"The order Marsupiata," says Mr. Waterhouse, "embraces a large assemblage of quadrupeds, amongst which are those animals familiarly known as Opossums and Kangaroos. At

* Travels in North America, vol. i. p. 172. The extract is given in Berghaüs and Johnston's Physical Atlas, from which all our information on the numbers and distribution of species is derived.

† The *mammalia* which are thus nourished are termed *placental*; the others the *non-placental*. Some naturalists regard this distinction of so great importance, that they consider the two divisions should rank as distinct classes.

the present period the great metropolis of the order is Australia; certain species of the group, however, are found in the Molucca Islands, and one genus, containing many species," (the Opossums) "is peculiar to the New World." Their remains have been found in a fossil state in Europe, as well as in Australia and South America.*

This order "presents a remarkable diversity of structure, (and consequently habits) containing herbivorous, carnivorous, and insectivorous species; indeed, we find among the Marsupial mammals analogous representations of most of the other orders of mammalia." Its most striking peculiarity is the premature birth of the young, and consequently the imperfect state of their development at that period. Professor Owen examined the young of the great Kangaroo, twelve hours after birth, and found its whole length from the nose to the end of the tail did not exceed one inch and two lines.† The corresponding measurement of a full-grown male would be between eight and nine feet.‡

"An animal so little advanced at the time of its birth as the young Marsupial, requiring a constant supply of food, and so ill fitted to bear the exposure which the more advanced young of other mammalia are subject to, must, it would appear, perish, were not some peculiar provision made for its safety. In the pouch of the female we find this provision." Here the young remain firmly attached to the nipple of the mother, and supplied without effort and in perfect security, with the nutriment it requires. "This pouch, when the animal is very young, has its orifice closed, and glued as it were, to the body of the parent by a peculiar secretion. When the young animal is more advanced, this secretion disappears, and the young frequently leave the pouch to return at will."

It has long been a question among naturalists in what manner is the young transferred to the pouch? On this point, an observation made on one of the female Kangaroos, at Knowsley, the seat of the Earl of Derby, gives the first precise informa-

* Our information is derived from a valuable work now in course of publication, Natural History of the Mammalia, by R. G. Waterhouse, Esq., and when practicable, we give the words of the original, marked by inverted commas.

† A line is the twelfth part of an inch.

‡ The body, measured from the tip of the nose to the root of the tail, being, according to Mr. Waterhouse, 63 inches, and the tail 42 inches.

tion. Immediately on the birth of the young one, the mother took it up in her fore-paws, opened the pouch with them, and deposited the young within. "In five minutes she was jumping about the place as if nothing had happened." *

Above one hundred and twenty species of Marsupial animals have been recorded, forming about one-twelfth of the entire number of mammalia. In size there is great diversity, ranging from a diminutive Opossum, which is little larger than the common Mouse, to the great Kangaroo † already mentioned; and the disparity in size is still greater if we extend our view to extinct species, as Professor Owen, from the fossil remains of one brought from Australia, is of opinion that the animal must, when living, have been of bulk superior to that of the Rhinoceros.

Some Marsupial animals are so inferior in certain structural peculiarities to the rest, and approach so much in these points to birds and reptiles, that they form a distinct section bearing a distinct name (*Monotremata*).‡ To this division belong the



Fig. 301.—Ornithorynchus.

* Proceedings of the Zoological Society, 12th Nov., 1844. Letter from the Rt. Hon. the Earl of Derby, President of the Society. In the instance referred to, the period of Utero-gestation was under one month.

† *Didelphys pusilla.*

‡ Signifying one orifice or outlet.

Echidna and the Ornithoryncus* (*Fig.* 301). The former is a little ant-eating animal, bearing externally some resemblance to a Hedgehog; the latter, a creature so anomalous, that when the first specimens of it arrived in Europe, and naturalists saw the body of a quadruped joined to the bill of a bird, they naturally suspected that the union was an artificial one. The real animal was in fact more wonderful than that which any dealer in "strange beasts," would have ventured to fabricate.

The Ornithoryncus is about eighteen inches long, and is called by the natives of Australia the *water-mole*. It frequents tranquil waters, seeking its food among aquatic plants, and excavating its burrows in the steep and shaded banks. The motions of its mandibles when procuring food are similar to those of a duck under the same circumstances.†

The Kangaroos of Australia, form the family (*Macropodidæ*)‡ best known to Europeans. "They are vegetable-feeding animals, browsing upon herbage like the Ruminants, and it appears that in some cases they chew the cud like those animals. Some are of great size, being nearly as tall as a man when in their common erect position; others are as small as the common Hare, and indeed greatly resemble that animal in general appearance."§ About the beginning of the present century, but three species of the present group were known. They are now regarded as a family, subdivided into many genera, and containing numerous species.

We have a very vivid recollection of a scene we once witnessed at the Surrey Zoological Gardens. On the abdomen of a large bluish-grey coloured Kangaroo, we noticed two appendages, which a second glance told us were the fore-feet of the young one. In another moment the head peeped out, and the young creature began gazing around. The mother then bent down, and with great tenderness, began licking its face and head. These endearments being finished, the young one came out, and was amusing itself on the ground, when alarmed by a sudden noise, it jumped into the pouch, and was seen no more, leaving us as much astonished, as when, in our boyish days, we

* From two Greek words, the one signifying a bird, the other a beak. It is sometimes called the "Duck-billed Platypus," (flat-foot.)

† A most interesting account of its habits is given by Mr. George Bennett in the Transactions of the Zoological Society of London, vol.i.

‡ The generic term *Macropus*, signifies long-footed. § Waterhouse.



Fig. 302.—Kangaroo.

first saw Harlequin escape from his pursuers by jumping through a picture.

Passing by the family (*Phalangistidæ*) which includes the "Flying Squirrel," we come to that of the Opossums (*Didelphidæ*). The Opossums are peculiar to America, and are found diffused from the southern border of Canada to Chili and Paraguay. "The largest known species scarcely equal in size the Common Cat, and by far the greater number, approaching more nearly to that of the Common Rat." "Their food consists chiefly of insects; but small reptiles, as well as birds and their eggs, are attacked by the larger species." The feet are shaped like hands, and the hinder feet are furnished with opposable thumbs.*

Some of the Opossums have no pouch,† or at least this receptacle for the young is found only in a very rudimentary condition in certain species, and the young, which at first remain firmly attached to the nipples, are subsequently carried upon the back of the parent. Such is the case in the species represented in the annexed figure. (*Fig.* 303). It might puzzle us to imagine by what means the young could retain their places, while the mother was rapidly changing her position

* Waterhouse's Mammalia.

† From this circumstance they are included by Mr. Ogilby in the same order as the Monkeys, and regarded as belonging to that division to which he has given the name *Pedimana*.



Fig. 303.—Merian's Opossum.*

among the branches of a tree. But the young Opossums adopt a ready mode of guarding against the danger of a fall, by entwining their long tails round the tail of their mother.

Order RODENTIA.†—RODENTS or GNAWING ANIMALS.

The preceding order was composed exclusively of animals belonging to foreign countries. The present is well represented among our native quadrupeds, as the British species amount to fourteen in number, and are illustrative of some of the most important families. The characteristics of the group are so well developed in the Rat and the Mouse, that the family to which they belong is regarded as typical of the order.

In the precise language of Mr. Jenyns the order is thus defined:—"Incisors two in each jaw, large and strong, remote from the grinders; tusks none; toes distinct with small conical claws."‡ The total number of species is six hundred and four, being two-fifths or nearly one-half of the entire number of mammalia known at the present time.§

* Fig. 303. *Didelphys dorsigera*, a native of Surinam, described and figured by Madame Merian, in the year 1719.

† From the Latin *rodere*, to gnaw; *rodens*, gnawing. The term *glires* is also applied to the present order, from the Latin *glis*, *gliris*, a Dormouse.

‡ Manual of British Vertebrate Animals.

§ G. R. Waterhouse, Esq., in Berghaüs and Johnston's Physical Atlas.

Geographical Distribution.—On this subject Mr. Waterhouse remarks, that "species of the same group most frequently have a wide range in the same, or nearly the same parallels of latitude; but when the species are inhabitants of the high ridges of mountains they will follow the course of the mountains, though that course may be in the opposite, or north and south direction." We learn from the same authority that the family of the Squirrels (*Sciuridæ, Fig.* 304) contains no less than 153 species. Few are found in South America; they are chiefly natives of the northern parts of that continent. Two, or perhaps three species occur south of the equator, but on the eastern side of the Andes only. They also become rare in the southern parts of the eastern hemisphere. The family (***Muridæ***) to which the Rats and Mice belong, contains 306 species, and has the greatest geographical range. That to which the Porcupine is referred (*Hystricidæ*) is, on the contrary, essentially American. "Out of about eighty-seven species appertaining to this family, seven only are found out of the South American province, and these belong to the most highly organized divisions of the family." The groups of islands comprehended under the term Polynesia, have no representatives of the present order, except such as there is reason to believe have been introduced by shipping.



Fig. 304.—SQUIRREL.

If instead of considering the Rodentia with reference to the great divisions of the globe, we limit our view to their distribution within the British Isles, we shall find that, out of fourteen species enumerated by Professor Bell, seven, or one half of the entire number, are absent from Ireland. This is a singular fact when we consider how small an arm of the sea separates the two countries. The annexed figure (305) repre-

sents one of the Voles, little animals, which in many points exhibit a greater affinity to the Beaver than to the Mouse, with which in popular language they are associated. Of these there are in England three species; yet the genus (*Arvicola*) to which they belong, is altogether unrepresented in Ireland.*



Fig. 305.—Short-tailed Field Mouse.

Teeth.—We turn from the geographical distribution of the Rodentia to the most striking characteristic of the order, the structure of the teeth. The Molar or grinding teeth, have

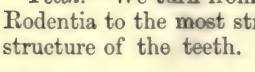


Fig. 306.—Molar Teeth of the Arvicola.

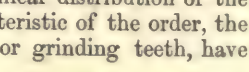


Fig. 307.—Molar Teeth of the Beaver.

ridges of enamel variously arranged (*Fig.* 306, 307), which keep up the inequality of surface, as they wear less rapidly than the other portions. The incisor teeth, with their chisel-shaped edges, are, however, more remarkable. If a carpenter

* The number actually recorded in the History of British Quadrupeds is fifteen; but since the publication of that valuable and beautifully illustrated work, Mr. W. Thompson has taken one from the number, by showing that the Irish and the Alpine Hare, instead of being distinct, are one species. To the "Report" of the latter gentleman on the Fauna of Ireland, we are indebted for the means of enumerating the British species which are not indigenous in Ireland. They are—

1. The Squirrel (?) (*Sciurus vulgaris*).
2. The Dormouse (*Myoxus avellanarius*).
3. The Harvest Mouse (?) (*Mus messorius*).
4. The Water Vole (*Arvicola amphibius*).
5. The Field Vole (*Arvicola agrestis*).
6. The Bank Vole (*Arvicola pratensis*).
7. The Common Hare. (*Lepus timidus*).

could lay hold of the wishing-cap of the fairy tale, and desire to possess a chisel which would never wear out, and would never become blunt, we might suppose that the handle of such a tool would have in itself the means of secreting the iron and the steel of which the blade is formed, of welding them together, and of giving them at the same time the needful polish and smoothness. And as such a gift would not partake of the imperfections of human workmanship, the new material would be deposited just in proportion as the old wore away, and the *temper* of the chisel would be neither too hard nor too soft, so that the edge would not be liable either to break or to turn, but remain at all times in working order. Such in reality is the mode of growth in the incisor teeth of the Rodentia (*Fig.* 298). New matter is ever added at the base, the tooth is ever growing, the enamel is deposited on the outer edge, the softer or inner portions of the teeth wear away, and thus the bevilled or sloping edge of these most efficient tools, is invariably preserved.

Knowing these facts, we cannot examine the teeth of the Rabbit, nor of the common Mouse, without being struck with the amount of design they exhibit, the care for the wants of the animal which they manifest, and the perfection in which the continual growth compensates for the constant wearing away. And these ideas become more vivid, and the convictions to which they lead more indelible, if we observe what takes place in cases where the usual order of things is interfered with. "When," to use the words of Professor Owen, "by accident an opposing incisor is lost, or when by the distorted union of a broken jaw, the lower incisors no longer meet the upper ones, as sometimes happens to a wounded Hare, the incisors continue to grow until they project like the tusks of the Elephant, and the extremities, in the poor animal's abortive attempts to acquire food, also become pointed like tusks: following the curve prescribed to their growth by the form of their socket, their points often return against some part of the head, are pressed through the skin, then cause absorption of the jaw-bone, and again enter the mouth, rendering mastication impracticable, and causing death by starvation." *

Hybernation.—We have in this order several examples of animals which *hybernate*, or pass the winter in a greater or less

* Odontography, p. 411, *vide* also plate 104, *Fig.* 5, in same work.

complete state of torpidity. Thus the Marmot (*Fig.* 308) of the Alps and Pyrenees dozes away the winter, until the sunshine



Fig. 308.—Marmot.

and the showers of April rouse it from slumber. The Hamster of the North of Europe, lays up in its winter quarters a plentiful store of grain, which it conveys from the fields in its capacious cheek pouches. The provident instincts of both the Squirrel and the Dormouse of England, need only be referred to. The Jerboa, or Jumping Rat of Egypt (*Fig.* 309), although it does not hybernate, establishes magazines of grain; and thus "provideth her meat in the summer, and gathereth her food in the harvest."

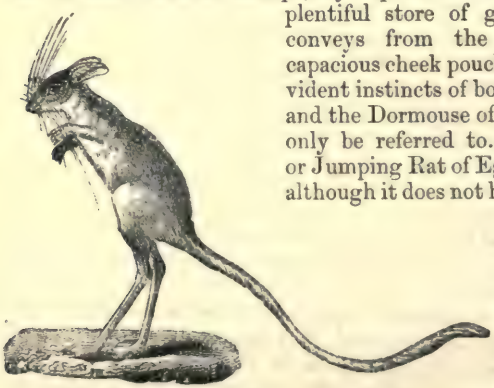


Fig. 309.—Jerboa.

Utility.—The annoyance, and occasionally the serious injury inflicted by some members of the present group, is universally admitted. On the other hand we should consider that substances which would soon be decaying and offensive, are removed by their agency; that the fur of some is much valued, and forms an extensive branch of trade, and that man himself, and many carnivorous beasts and birds, derive from different species of these animals an important supply of food.

If we should be inclined to question which is greater, the good or the evil of which they are the unconscious instruments, we must not limit our attention to one species, one country, or one period, but let our views be wide, comprehensive, and unprejudiced, ever bearing in mind, that after all, we only "know in part," and "see as through a glass darkly." And this considered, we shall probably arrive at the conclusion, that here, as in all other departments of nature, so far as we are capable of observing, there springs

"From partial evil universal good."

In concluding our notice of Rodent animals, we may briefly refer to one or two well-known species. Professor Bell remarks, in treating of the Common Squirrel of England (*Sciurus vulgaris*):—"The form and habits of this elegant and active little creature combine to render it one of the most beautiful and entertaining of our native animals." In Ireland we are debarred from the opportunity of witnessing its gambols; for in that country it is not now indigenous. There is a tradition that the Squirrel was common in Ireland before the destruction of the native woods. "It was re-introduced a few years ago into the county of Wicklow, where it is said to be fast increasing in number;"* and it abounds in some places in the counties of Longford and Westmeath.†

The fur of the English and Scotch Hare is well known as valuable to the hatter, while that of the Irish Hare is worthless. It is only of late years that it has been ascertained that the difference is not confined to the fur, but that the two animals are specifically distinct;‡ and still more recently, Mr. W. Thompson has arrived at the conclusion that the Hare of Ireland is identical with that known as the Alpine, or varying Hare of the Scotch mountains, notwithstanding the great difference in locality and habits. In this opinion Mr. Waterhouse concurs; so that it may now be regarded as an established fact, there are in reality but two species of Hares in these islands.

The Beaver (*Fig.* 310) is an animal associated in our minds with the wondrous labours and social instincts which it mani-

* Thompson's "Report."

† My authority for this fact was the late Miss Edgeworth—or to use that name by which her memory is endeared to the young, "Maria Edgeworth."

‡ Bell's British Quadrupeds. Thompson on the Irish Hare. Transactions of the Royal Irish Academy, vol. xviii.

fests, in the solitudes frequented by the North American hunters. Professor Owen has, however, proved from historic and legendary evidence, the former existence of a species of



Fig. 310.—Beaver.

Beaver (*Castor Europæus*) in the British Islands; besides the still more conclusive proof afforded by the remains of that animal associated with those of other denizens of the forest, the Wild Boar, the Deer, and the Wolf.*

Order EDENTATA.—TOOTHLESS ANIMALS.

A few of the animals belonging to the present order are destitute of teeth. In this respect they resemble the Ant-eater of South America, whose long cylindrical tongue, covered with glutinous saliva, furnishes the means of entrapping its insect prey. But with few exceptions the Edentata cannot be described as *toothless*, the true characteristic is the absence of teeth from the front part of the jaw, where in the preceding group they were so fully developed.

The present order is composed entirely of foreign species, and has been divided into three groups, one represented by the Ant-eater, a second by the Armadillo (*Fig.* 311), and the third by the Sloth (*Fig.* 312).

The Armadillos (*Dasypus*) are peculiar to the New World; no animals encased in a similar bony covering are found in

* History of British Fossil Mammalia and Birds.

any other part of the globe. They extend from the banks of the Orinoco, through the whole of South America, and occupy the lower regions of the Andes, to the same elevation as the Sloths, about 3000 feet.* Their food is partly of animal and partly of vegetable substances and fruits. One species known as the Giant Armadillo, is more than three feet in length. The others are small in size, and compared with the remains of an extinct species,† now in the Museum of the College of Surgeons, London, are as diminutive as the existing Tortoises, contrasted with the remains of that colossal species already mentioned (*ante*, p. 278) from the Himalayan mountains.

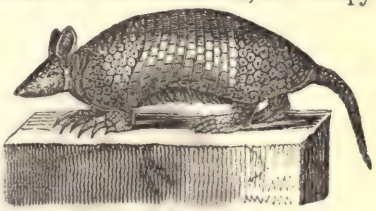


Fig. 311.—Armadillo.

The Sloths (*Bradypus*), of which there are only four species, are found from the southern limits of Mexico to Rio de Janeiro.‡ Their food consists exclusively of leaves and fruits. The Sloth has been spoken of by naturalists of high reputation as disproportioned in its parts, grotesque, imperfect, to whom existence must be a burden. Such opinions have been exploded by a better knowledge of the habits of the animal. It is not destined to live upon the earth, but among the branches of trees, and not *on* them like the Squirrel, but *under* them. These things being known, its supposed defects turn out in reality to be perfections; and all its structural peculiarities but so many new adaptations of the animal frame to new functions, each declaring how presumptuous is man, who in his ignorance dares to question the consummate wisdom and perfection displayed in all the works of Nature.

We are indebted to the kindness of Mr. R. Ball, the zealous

* Berghaüs and Johnston's Atlas.

† It is fully described by Professor Owen in a separate memoir, and named *Glyptodon*, from the Greek *Glyptos*, sculptured; *odous*, tooth. *Dasypus*, from the Greek *dasys*, hairy; *pous*, a foot.

‡ *Bradypus*, Gr. *bradys*, tardy, slow; *pous*, a foot, being nearly the same as the Latin term *Tardigradus*, slow-paced.

Some of the flesh-eaters being in the habit of rooting for their food, have been termed *Effodientia*, or diggers. These terms are not in all cases descriptive of the habits.

secretary of the Royal Zoological Society of Ireland, for the accompanying figure (*Fig.* 312). It represents the Unau, or two-toed Sloth,* the first ever seen alive in these countries, and is copied from a prize drawing belonging to that Society.



Fig. 312.—Unau, or Two-toed Sloth.

"The Sloth," Mr. Waterton remarks, "is the only known quadruped that spends its whole life suspended by his feet from the branches of trees. The Monkey and the Squirrel seize a branch with their fore-feet, and pull themselves up, and rest or run upon it; but the Sloth, after seizing it, still remains suspended; and, suspended, moves along under the branch till he can lay hold of another." The rapidity of the movement is well illustrated by Mr. Waterton in the following anecdote:—"One day as we were crossing the river Essequibo, I saw a large two-toed Sloth on the ground upon the bank. How he got there nobody could tell; the Indian said he never had surprised a Sloth in such a situation before; he could hardly have come there to drink, for both above and below the place the branches of the trees touched the water, and afforded him an easy and a safe access to it. Be this as it may, though the trees were not twenty yards from him, he

* This animal formed the subject of a highly interesting Lecture, delivered by Mr. Ball at one of the evening meetings of the Society. It was published in *Saunders's News-Letter*, April 15, 1844, and gives a general view of the Sloths, recent and fossil.

could not make his way through the sand time enough to escape before we landed. As soon as we got up to him he threw himself upon his back, and defended himself in gallant style with his fore legs. 'Come, poor fellow,' said I to him, 'if thou hast got into a hobble to-day, thou shalt not suffer for it. I'll take no advantage of thee in misfortune. The forest is large enough both for me and thee to rove in. Go thy ways up above, and enjoy thyself in these endless wilds; it is more than probable thou wilt never have another interview with man. So fare thee well.' On saying this I took a long stick, which was lying there, held it for him to hook on, and then conveyed him to a high and stately mora tree. He ascended with wonderful rapidity, and in about a minute he was almost at the top of the tree. He now went off in a side direction, and caught hold of the branches of another tree, proceeding in this manner towards the heart of the forest. I stood looking on, lost in amazement at this singular mode of progress. I followed him with my eyes till the intervening branches closed in between us, and then I lost sight for ever of the two-toed Sloth."

Among the extinct animals of the present order, is one whose massive skeleton has procured for it the expressive appellation of *Megatherium*.* Its length, including the tail, must have been more than fourteen feet, and its height upwards of eight feet. The thigh bone was twice the thickness of that of the largest Elephant; the fore-foot must have measured more than a yard in length, and more than twelve inches in width, and was terminated by an enormous claw. The width of the upper part of the tail could not have been less than two feet.† Other extinct quadrupeds allied to this in many points of structure have been discovered, and the group deriving a name from its colossal leader, is spoken of as that of the *Megatherioid* animals. Their structure and general habits are most ably treated of by Professor Owen, in a memoir upon one species (*Mylodon*‡ *robustus*), of which the skeleton is now in the splendid museum of the College of Surgeons, "set up" in the attitude shown in the annexed figure (*Fig.* 313).

In the course of this volume examples have been adduced of the exercise which the study of natural history gives to the

* Gr. *Mega*, great; *therion*, a beast.
† Dr. Buckland's Bridgewater Treatise. Vide also Penny Cyclopædia.
‡ Gr. *myle*, a mill; *odous*, a tooth.

observant faculties, the habits of arrangement which it requires, the generalizations to which it leads, the inexhaustible pleasures which it affords, and the devotional feelings with which it is associated. We would now wish the reader to regard it in a new light, as affording for the reasoning powers a field for their exertion not less beneficial than other departments of science,



Fig. 313.—Mylodon.

whose claim to be admitted into our schools and colleges have long since been recognized. As an instance of inductive reasoning, we now bring forward Professor Owen's admirable memoir on the Mylodon.

"From the structure of the teeth he infers that both the Megatherium and Mylodon must have been phyllophagous, or leaf-eating animals;* whilst from their short necks, the very opposite extreme to the Camelopard, they never could have reached the tops of even the lowest trees. Cuvier had suggested that they were fossorial or digging animals. Dr. Lund, a Danish naturalist, had considered the Megatherium to be a scansorial or climbing animal; in short, a gigantic Sloth. After a multitude of comparisons, Professor Owen rejects the explanation of all his predecessors. He shows that the monstrous dimensions of the hinder parts of the body, and the colossal and heavy hinder legs, could never have been designed either to support an animal which simply scratched the earth for food, or one which fed by climbing into lofty trees, like the diminutive Sloth; and he further cites the structure of every analogous creature, either of burrowing or climbing habits, to prove, that in all such, the hinder legs are comparatively light. What then was the method by which these extraordinary monsters obtained their great supplies of food?"

The bones which correspond with those termed in the human body the hip-bones, were of enormous size, and were conjoined with muscular masses of unwonted force. "Professor Owen supposes that the animal first cleared away the earth from the roots with its digging instruments, and that there seated on its hinder extremities, which, with the tail,† are conjectured to have formed a tripod, and aided by the extraordinary long heel as with a lever, it grasped the trunk of the tree with its fore-legs. Heaving to and fro the stateliest trees of primæval forests, and wrenching them from their hold, he at length prostrated them by his side, and then regaled himself for several days on their choicest leaves and branches, which till then had been far beyond his reach."‡

* They form the family *Gravigrada*, "heavy paced," of Owen.

† There is scarcely a doubt, that the tail of the Mylodon was supplied with an arrangement of arteries similar to that which is known to exist in the arm of the Sloth, and which serves to enable the animal to maintain without fatigue his position, when suspended from the branch of a tree. This is confirmed by the discovery by Dr. Allman, of a similar arrangement in the tail of the Armadillo; and it is known that this animal can stand for a short time tripod-like, upon the tail and hind-legs. Mr. Ball, in the lecture referred to, regards this arterial arrangement as typical of that which must have existed in the Megatherioid animals.

‡ The substance of Professor Owen's Memoirs on the Mylodon has been

The theory thus proposed is, as Professor Owen remarks "strictly in accordance with, as it has been suggested by, the ascertained anatomy of the very remarkable extinct animals, whose business in a former world it professes to explain;" and he sums up his reasoning in the following words:—"All the characteristics which exist in the skeleton of the Mylodon and Megatherium, conduce and concur to the production of the forces requisite for uprooting and prostrating trees, of which characteristics, *if any one were wanting the effect would not be produced.*"

Order RUMINANTIA.—RUMINATING ANIMALS.

"Mightiest of all the beasts of chase,
That roam in woody Caledon,
Crashing the forest in his race,
The mountain Bull comes thundering on.

"Fierce on the hunter's quiver'd band,
He rolls his eyes of swarthy glow,
Spurns with black hoof and horn, the sand,
And tosses high his mane of snow."

Scott's "Cadyow Castle."

"The order Ruminantia is distinguished from all the other orders of mammalia, by the existence of four stomachs, arranged for the act of ruminating or chewing the cud. These animals are essentially herbivorous, and are all possessed of the cloven hoof; and it is only among them that species are met with whose foreheads are armed with horns. This order, which is one of the most natural and best defined* of all the primary groups into which the mammalia have been divided, is principally represented by the Ox, the Sheep, the Goat, and the Deer; but it is usual also to classify with them the Giraffe, Camels, Antelopes, Llamas, &c. They are subdivided into nine genera, comprising in all one hundred and forty-eight species,

so ably abstracted by Sir R. I. Murchison, in his Address as President of the Geological Society, 1843, that we have, as far as possible, availed ourselves of the language employed by that eminent geologist.

* This opinion, though expressed by Cuvier, and generally received, has been called in question by Professor Owen, from evidence principally afforded by his researches into the structure of extinct species of *Ruminantia* and *Pachydermata*.

forming about one-tenth of all the mammalia.* Following the general law of distribution, the Ruminantia are most numerous in equatorial regions; but, as if created expressly for the use of the human family, they are distributed over all latitudes in the northern hemisphere, at least from the equator to the regions within the arctic circle; so that, wherever man is found, he is accompanied by those animals most necessary for the supply of his wants and comforts, and most



Fig. 314.—Rein-deer.†

* The following table is extracted from that given by Mr. Waterhouse in Berghaüs and Johnston's Physical Atlas:—

1. (*Camelus*)	Camels	2
2. (*Auchenia*)	Llamas	3
3. (*Moschus*)	Musk Deers	7
4. (*Cervus*)	Deers	38
5. (*Camelopardalis*)	Giraffes	2
6. (*Antilope*)	Antelopes	48
7. (*Capra*)	Goats	14
8. (*Ovis*)	Sheep	21
9. (*Bos*)	Oxen	13
	Total number of species,	148

128 species belong to the Old World; 23 only to the New.

† Remains of the Rein-deer have been discovered near Dublin, associated with those of the Great Irish Deer. They had previously been found both in Devon and Norfolk; there can therefore be no doubt that the Rein-deer was at one time an inhabitant of these countries. Owen's Fossil Mammalia. Oldham, in Journal of Geological Society of Dublin, Nov. 1847.

conducive to his progress in arts and civilization. From them he derives a considerable portion of his food and clothing, whether in a savage or a civilized state of society. Their milk, their flesh, their wool, hides, horns, and hoofs, are all converted to his uses; whilst from many of them he derives the most valuable assistance in the labours of the field, and in the transport of commodities. Thus the Rein-deer (*Fig.* 314), as is well known, forms the chief comfort and the principal means of subsistence to the Laplander; and the Yak or Kashgow, confers similar benefits on the inhabitants of Thibet and Pamir."

From this general distribution of the Ruminating animals, the continent of Australia must be excepted; among the peculiar Fauna of that country, as well as in Madagascar, New Guinea, and the greater number of the South Sea Islands, no species of this order has yet been discovered.



Fig. 315.



Fig. 316.

Whether the foot is cloven as in the Deer (*Fig.* 315), and other animals of the present order, or encased in a solid hoof as in the Horse (*Fig.* 316), it is equally unfitted to assist in the capture of living prey, and the food consequently consists of vegetables. The molar teeth, as might be expected, are so formed as to be peculiarly efficient instruments for the mastication of such substances; and we learn from Professor Owen, that, "not only orders and genera, but even species, are characterized by the various patterns which result from the various forms, directions, and proportions in which the enamel and cement alternate with the dentine," or substance of the teeth, in the crowns of the complex molars.*

In the brief notice here given of the ruminating animals, the facts relating to their geographical distribution are given on the authority of Mr. Waterhouse, and occasionally in his words. Some well-known example is adduced of each of the nine groups enumerated by that eminent naturalist.

* Odontography, p. 527.

I. (*Camelus.*)—"The Arabian Camel (Djemal of the Arabs), from which the Dromedary is only distinguished by higher breeding and finer qualities—both being possessed of only one hump*—is a native of Asia, where, from the earliest ages to the present day, it has formed the chief means of communication between the different regions of the East. Its present geographical distribution extends over Arabia, Syria, Asia Minor, to the foot of the Caucasian chain, the south of Tartary, and part of India. In Africa, it is found in the countries extending from the Mediterranean to the Senegal, and from Egypt and Abyssinia to Algiers and Morocco. It is also very abundant in the Canary Islands."

"After the conquest of Granada, the Arabian Camel was introduced into Spain, by the Moors, and at that time it was abundant in the southern provinces, but as a species it is now extinct. The only place in Europe where this Camel is now reared is at Pisa."

II. (*Auchenia.*)—The Llamas, which have been justly termed the "Camels of the New World," differ from the former from being of smaller size, and in the absence of the hump. They belong exclusively to South America, and chiefly to the western part of the great chain of the Andes. Unlike their Old World relatives who inhabit "Araby the blest," and other sunny regions, the Llamas are found amid the bleak and rocky precipices bordering on the limit of perpetual snow. Owing to the low temperature of Patagonia, they approach the vicinity of the sea. "From this they spread over the elevated regions of the Andes, and in large herds attain, on Chimborazo, the limit of perpetual snow, which there reaches a height of 15,800 feet."

III. (*Moschus.*)—The Musk Deer are so called from the species whence the substance called "musk" is derived. They are all distinguished by the absence of horns. Their habitat is the mountains of Central and Southern Asia.

IV. (*Cervus.*)—The Deer combine in the highest degree the characteristics of elegance of form, grace, and fleetness. The Elk or Moose Deer of America (*Alces palmata*) exceeds in size any species now living. It was, however, much surpassed by that extinct species known as the "Irish Elk,"†

* The Camel with two humps is regarded only as a variety, not as a distinct species.

† It now forms the representative of a distinct sub-genus, and is named *Megaceros Hibernicus*, from the Greek *mega*, great; *keras*, a horn.

and especially as regards the size of the antlers. In the Moose, the span of the antlers between the extreme tips is four feet; in the extinct Irish species, it is eight feet, and the vertebræ of the neck are proportionally larger, so as to bear the weight of the head and its massive appendages. The name of Irish Elk is objectionable, as the animal was not an Elk but allied to the Fallow Deer; and also as the remains are not peculiar to Ireland. They have been met with both in the Isle of Man and in England. In the latter country they are found associated with the fossil remains of a Mammoth,



Fig. 317.—Giraffe.

a Rhinoceros, and other extinct mammalia of which they had been cotemporaries.*

Of the three species of Deer which are at present living in these countries, the Fallow Deer (*Cervus dama*) is that which is the common denizen of the parks. The Red Deer (*C. elaphus*), which is the largest species, still exists in numbers amid the solitude of the Scottish mountains, and is not quite extinct in some retired localities in Ireland.† The Roebuck (*C. capreolus*), which is smaller than either of the other two, is unknown in Ireland and rare in England, but is yet to be found enjoying a wild life among some of the wooded mountains of Scotland.

V. (*Camelopardalis.*) — The Giraffe or Camelopard (*Fig.* 317), of which only two species are known, is confined to the continent of Africa. It browses upon the foliage and tender shoots of trees, and has a tongue so constituted as to serve as an instrument for pulling them down, as would be done by the proboscis of the Elephant.

VI. (*Antilope.*)—The traveller among the Alps or the Pyrenees describes one species of this group, the Chamois, and the poets of eastern countries have celebrated the praises of another, the Gazelle (*Fig.* 318).‡ They may be regarded as holding their head-quarters in Africa. That continent alone has thirty-four species of Antelopes, while Asia has ten, Europe two, and America only one. The Deer and the Antelopes together, comprise more than half of all the existing species of ruminating animals.



Fig. 318.—GAZELLE.

VII. (*Capra.*)—The Goats also are inhabitants of Alpine regions; but while in this respect they agree with the Antelope, their favourite tracts are in a different quarter of the globe, for the greatest number of species is found in Asia.

VIII. (*Ovis.*)—"Sheep, the most ancient of our domestic

* Owen on British Fossil Mammalia.

† Thompson's Report on the Fauna of Ireland.

‡ "Her eye's dark charm 'twere vain to tell,
But gaze on that of the Gazelle,
It will assist thy fancy well;
As large, as languishingly dark."—BYRON.

animals, may be traced originally to the countries of Western Asia. They herd in flocks in a wild state on the inaccessible mountainous districts of Asia, Europe, Africa, and America."

The elevation at which some of these creatures habitually live is very remarkable, and to the zoologist a subject of philosophic interest. The Chamois is found between the upper limit of the trees, and the line of perpetual snow, which in the Alps is 8,900 feet; and is 700 feet less on the northern than on the southern declivities of these mountains. The Goat of Cashmere browses on the comparatively naked table-lands of Thibet, at the height of from 10,000 to 13,000 feet above the level of the sea. The Pamir Sheep, or Rass (*Ovis polii*), lives at the still greater height of 15,600 feet in the table-land of Pamir, eastward of Bokhara; and the Burrhel (*Ovis burrhel*) inhabits the highest ridges of the Himalayan chain, where it is described as "bounding lightly over the incrusted snows, at an altitude where its human pursuers find it difficult to breathe."



Fig. 319.—Bison.

IX. (*Bos.*)—The present group may be represented by our domestic Oxen, which have ever been associated with the field labours and the domestic comforts of man. But the species most celebrated are probably the ferocious Buffalo of Southern Africa, and the Bison (*Fig.* 319), which roams in vast herds over the trackless prairies of America.

The extinct animals of this tribe afford another example of the manner in which the historian and the naturalist may at times assist each other's researches. The Romans, when they

first penetrated the wilds and forests of uncivilized Europe, discovered two kinds of gigantic oxen. That which they distinguished by its shaggy coat and mane, may be recognized in the still untamed Aurochs of Lithuania. The other is described by Cæsar as being "not much inferior to the Elephant in size, and though resembling the common Bull in colour, form, and general aspect, yet as differing from all the domestic cattle in its gigantic size, and especially in the superior expanse and strength of its horns."*

Remains of both these species† have been found in England in the same deposits and localities; and it is most satisfactory, as Professor Owen remarks, "to find such proof of the general accuracy of the brief but interesting indications of the primitive mammalian fauna of those regions of Europe which may be supposed to have presented to the Roman cohorts the same aspect as America did to the first colonists of New England."

PACHYDERMATA.—THICK-SKINNED ANIMALS.

"Beside him stalks to battle
The huge earth-shaking beast—
The beast on whom the castle
With all its guards doth stand;
The beast who hath between his eyes
The serpent for a hand."

MACAULAY'S "LAYS OF ANCIENT ROME."‡

THE animals of the present order are, in their general habits, herbivorous. One of their most obvious characteristics is the toughness and great thickness of the skin, as manifested in the Hippopotamus and other species. Hence the name *Pachydermata*, signifying *thick-skinned*, is that by which they have been designated.

* Owen's Fossil Mammalia.

† A third species of smaller size has been found in England (*vide* Owen, p. 508), it has also occurred in Ireland. R. Ball, "Proceedings of the Royal Irish Academy," January, 1839.

‡ The author states in a note that *Anguimanu*, or snake-handed, is the old Latin name for an Elephant. Lucretius, ii. 538, v. 1302.

The order contains but nine genera, divided into thirty-nine or forty species,* and comprises the most gigantic of all living quadrupeds. They are found chiefly in the countries of the torrid zone. No animal whatever belonging to this order is found in Australia.

The Indian and the African Elephants are distinct species, and these terms point out the countries in which they are indigenous. The Hippopotamus or "River-horse," whose bulk is scarcely inferior to that of the Elephant, is peculiar to Africa, and even to certain districts of that continent. There are no less than seven species of Rhinoceros, which are distributed through both Asia and Africa. Of the group of which the Swine is the representative, the Wild Boar (*Fig.* 320) only is found in any part of Europe. The Wart Hogs



Fig. 320.—Wild Boar.

belong solely to Africa, and the Peccaries to America. The Tapirs, which are distinguished from all other animals by their prolonged and flexible snout (*Fig.* 292), are common to both the Old and the New World.

The Horse is universally distributed, either in a wild or a domesticated state. Fossil remains of a species distinct from

* They are thus enumerated by Berghaüs and Johnston:—

Elephants,	2 species.	Damans,	3 species.	Peccaries,	2 species.
Hippopotamus,	1† „	Swine,	9 „	Tapirs,	3 „
Rhinoceros,	7 „	Wart Hogs,	3 „	Horses.	9 „

† It is generally considered that there are at least two species.

any now existing have been found both in North and South America. This circumstance has elicited from Mr. Darwin the remark—"It is a marvellous event in the history of animals, that a native kind should have disappeared, to be succeeded after ages by the countless herds introduced with the Spanish colonist."* The wild Asses extend from Siberia to Egypt; and the different species of Zebra (*Fig.* 321) throughout central and southern Africa, some inhabiting the plains, others selecting the mountains.



Fig. 321.—Zebra.

Having briefly given the geographical distribution of the leading groups of the present order, we turn to the Elephant, the "half-reasoning Elephant," as he has been termed by the poet. We do so, not for the purpose of bringing forward anecdotes illustrative of his strength, docility, or sagacity; his inoffensive habits, or his utility to man; but that we may advert to certain peculiarities of structure, and to the interest which attaches to him in reference to species which have passed away, but which have left scattered over Europe the memorials of their former existence.

The food of the Elephant consists not merely of leaves, but of the twigs and branches of trees. It is needful, therefore, that he should have teeth fitted to grind down the woody fibre, and with some principle of renovation which would make up for the continual wearing away. The teeth are composed of three substances of different degrees of hardness; the "den-

* Voyages of the Adventure and Beagle, vol. iii. p. 150.

tine," which constitutes the principal component; the "enamel," which is a much harder substance; and the "cement," which is a softer one, and serves to unite the plates of which the tooth is composed. The unequal density causes the surface to wear away in an unequal manner, and hence the property which makes a mill-stone most valuable is secured. The arrangement to make good what a mechanic would call "the wear and tear" of the apparatus is not less effectual. The teeth are ever growing, not as in the Rodentia (*ante*, p. 388),



Fig. 322.—Indian Elephant.

by a deposit of new matter at the base, but by the development of new teeth. We are accustomed to see a new tooth come forth from the mouth of a child from the place where the former tooth had been shed; but in the young Elephant the plan of development and succession is altogether different. Each tooth is formed in a membranous bag, enclosed in a chamber of bone, forming part of the massive jaw. They are successively developed, so that an Elephant may have in each jaw not less than six of these enormous molar teeth in the course of its life, or twenty-four in all, although never more than two are seen in each jaw at the same time. As the

first tooth wears away, the second tooth is advancing forward; when the first becomes worn and useless, the second tooth takes its place, its former position being now occupied by the third tooth, which in course of time is carried forward to the front of the mouth, serves its distinct purpose, and when worn down is succeeded by that which was the fourth.

"There are few examples of natural structures," says Professor Owen, "that manifest a more striking adaptation of a highly complex and beautiful structure to the exigencies of the animal endowed with it, than the grinding teeth of the Elephant. Thus the jaw is not encumbered with the whole weight of the massive tooth at once, but it is formed by degrees as it is required; the sub-division of the crown into a number of successive plates, and of the plates into sub-cylindrical processes, presenting the conditions most favourable to progressive formation."* Another advantage is pointed out by the same high authority:—"The tooth in front, which is partially worn down, is fitted for the first coarse grinding of the branches of a tree; the transverse enamelled ridges of the succeeding part of the tooth divide the food (as it passes on towards the throat) into smaller fragments, and the posterior islands and tubercles of enamel pound it to the pulp fit for deglutition."

It may readily be supposed that the number and thickness of the plates, the shape of the teeth, and the different patterns in which the enamel is arranged, form characters by which the teeth of the same species in different stages of maturity may be recognized, and that they also furnish the means of separating those of the African from the Asiatic Elephant; and both of these from that extinct species known as the Mammoth (*Elephas primigenius*).

The teeth of the Mammoth, which are thus easily distinguishable, are found in the superficial unstratified deposits of the continent of Europe; and with them are associated the remains of two other animals, belonging to the present order, and now found only in warmer latitudes—the Hippopotamus and Rhinoceros.

When such statements were first made by Cuvier, it was no wonder they were received with incredulity; and that even when they were admitted, reference should be made to the Elephants introduced by Pyrrhus in the Roman wars, and to

* On British Fossil Mammalia.

the stranger quadrupeds from conquered countries, as explanatory of their occurrence. But their abundance proved that such a cause was insufficient for the effect; and when it was shown that they were equally plentiful in England, where many living Elephants were not likely to have been introduced, and that they had also occurred in Ireland,* where a Roman legion never encamped, there was no alternative but to admit that those huge quadrupeds must have inhabited the countries in which their remains had been discovered.

Professor Owen, in his work on the fossil mammalia of Britain, gives descriptions and illustrative figures of the remains of the Mammoth,† of a large Hippopotamus, two species of Rhinoceros, and one of a Mastodon, an animal equal in bulk to the Elephant, and, like it, furnished with tusks and a flexible proboscis. These mighty quadrupeds once ranged over tracts which are now occupied by the busy towns, the verdant plains, and

"The stately homes of England."

Their bones, too, are sometimes found "full fathom five" in the seas that encircle her shores; and the trawling net of the fisherman, when it encounters their heavy mass, has been known to break under its burthen. "Such occurrences," as the Professor well remarks, "recall to mind the adventures of the fisherman narrated in the Arabian Nights; but the fancy of the Eastern romancer falls short of the reality of this hauling up, in British seas, of Elephants more stupendous than those of Africa or Ceylon."

* The occurrence in Ireland of the molar teeth of an Elephant was made known by Neville and Molyneux, in 1715.

† The entire carcase of a Mammoth was discovered in 1799, among the blocks of ice at the mouth of the river Lena, in Siberia; and so perfectly had the soft parts of the body been preserved from decay by their icy covering, that the flesh, as it became exposed, was devoured by wolves and bears. It was clothed with a double garment of close fur and coarse hair, some of it sixteen inches in length, and by means of this thick shaggy covering, was specially adapted for living in that climate. The animal was a male, with a long mane on the neck. The skeleton is set up in St. Petersburg.

Order CETACEA—WHALES, DOLPHINS, PORPOISES.

> ——————— "Part huge of bulk,
> Wallowing unwieldy, enormous in their gait,
> Tempest the ocean: there Leviathan,
> Hugest of living creatures, on the deep
> Stretched like a promontory, sleeps or swims,
> And seems a moving land."—Milton.

In passing from one order of mammalia to another, the scene changes like that of a panorama. From the Pachydermata, living on the land beneath the burning sun of India or of Africa, we turn to the Cetacea, dwelling in the seas, and fixing their head-quarters

> "In thrilling regions of thick-ribb'd ice."

These animals are distinguished by their fish-like form—their flat horizontal tail—and by the anterior extremities being in the form of fins. They were divided by Cuvier into two families, the herbivorous and the carnivorous, according to the nature of their food. The carnivorous Cetacea, to which our attention shall be restricted, are arranged in three groups, represented by the Dolphin, the Spermaceti Whale, and the Baleen Whale, in all of which the nostrils are situated on the crown of the head, and act as blow-holes.

Delphinidæ.—The common Dolphin (*Delphinus delphis*) is occasionally met with on our coasts. The very name is associated with classic fable,* and with the splendid creations of our own Shakspeare;† and its habits are such as to excite universal interest whenever they are observed. "The exces-

* Arion, having charmed the Dolphins by his music, was carried by one of them on its back. Amphitrite's car is represented as drawn on the sea by a group of Dolphins.

† The passage referred to is that in the Midsummer Night's Dream:—

> ——————— "I sat upon a promontory,
> And heard a Mermaid, on a Dolphin's back,
> Uttering such dulcet and harmonious breath
> That the rude sea grew civil at her song."

sive activity and playfulness of its gambols, and the evident predilection which it evinces for society, are recorded by every mariner; numerous herds of them will follow and surround a ship in full sail, with the most eager delight throwing themselves into every possible attitude, and tossing and leaping about with elegant and powerful agility, for no other apparent reason than mere pastime."*

The common Porpoise (*Phocæna communis*, *Fig.* 323) is

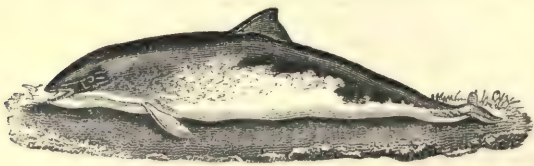


Fig. 323.—Porpoise.

scarcely less playful or less sociable. It is the most common species of Cetacea around our coasts, entering our bays in pursuit of shoals of herrings and other fish, and attracting attention by the manner in which it rolls over, as it comes to the surface to breathe. A herd of them may be sometimes seen, indulging in their unwieldy gambols, and chasing each other in sport. "On the approach of a storm, or even in the midst of the tempest, they appear to revel in the waves, showing their black backs above the surface, and often throwing themselves wholly out of the water in their vigorous leaps." The length of the body is from four to six feet.

To the same group belongs the Bottle-head Whale (*Hyperoodon*), occasionally taken on our shores; the Round-headed Porpoise or Caaing Whale (*Phocæna melas*), which appears in herds of several hundreds; and the Narwhal (*Monodon monoceros*), whose single projecting tooth, six feet or more in length, has procured for it the name of Sea-Unicorn.

Physeteridæ.—"The common Cachalot, or Spermaceti Whale, is well known," says Professor Bell, "as affording that peculiar and useful substance from which it takes its common name. The enormous size of the head, in length very nearly equalling, and in its bulk even surpassing, half of

* Professor Bell's History of British Quadrupeds. From this work we have enriched our brief notice of the Cetacea with several extracts.

the whole animal, is principally dependent upon the immense quantity of spermaceti, which is contained in a thick dense bag, divided into compartments, and placed in the front part of the head. This substance, which exists in a fluid state in the living animal, is also found along each side of the back, and in some other parts of the body."

The Cachalot reaches the length of seventy feet. In its enormous bulk, therefore, it equals or even surpasses the common or Baleen Whale. Its strength is enormous. A single blow of the tail will dash a boat to pieces; "and there is a well-known authenticated instance on record of an American ship of large size being stove in and foundered by the blow inflicted by the head of an infuriated male Cachalot of large size." Though small fishes have been found in its stomach, its principal food is Cuttle-fish.

Balænidæ.—The common Whale (*Balæna mysticetus*, *Fig.* 324) feeds, as is well known, on minute crustacea, mollusca

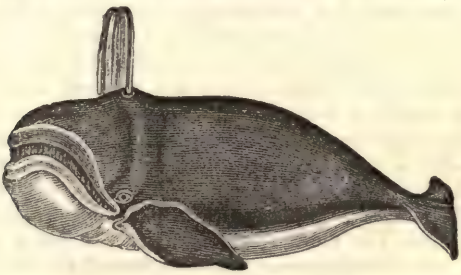


Fig. 324.—Baleen Whale.

(*ante*, p. 175), and medusæ (*ante*, p. 42). It is so greatly reduced in numbers in the Greenland seas, that Baffin's Bay, Hudson's Bay, and other localities made known by the enterprise of British seamen, are now the principal seats of the "fishery"—a term we would gladly change, as it tends to keep up the vulgar and erroneous idea that the Whale is a fish. Its affection to its young, its importance to man, and the dangers incurred in its pursuit, are attractive subjects; but instead of entering upon their consideration, we prefer devoting our limited space to points of structure exhibited in the Whale, and, with some modifications, found throughout all the animals of the present order.

The position of the tail in Whales is horizontal; in fishes it is vertical (*ante*, p. 204); and the adaptation in each instance is admirably fitted to the wants of the animal. For fishes it is used as an instrument for progression in the water, and they may speed onwards in their course at nearly the same uniform depth. But by the very nature of their organization, Whales are compelled to rise to the surface for each respiration;* and as the tail is horizontal, it acts as an oar of inconceivable power; its superficial measurement in the larger species being not less than one hundred feet.

"But if this powerful implement be necessary to raise the Whale into contact with the atmosphere, the immense depth of water from which he is thus raised implies a superincumbent pressure so immense as to require some extraordinary condition of the body to prevent its absolute destruction. The most obvious means for meeting this enormous pressure, which in most cases must amount to 154 atmospheres, or about a ton upon every square inch, is a thickening of the integument, or the production of some incompressible substance, which shall invest the whole animal; and we find this object to be effected in a manner which must excite the greatest admiration."† Professor Jacob, of Dublin,‡ has shown that the structure in which the oil is deposited, and which is called "blubber," is the true skin of the animal, modified for the purpose of holding this fluid oil, but still the true skin. It consists of an interlacement of fibres, crossing each other in every direction, as in common skin, but more open in texture, to leave room for the oil. A soft wrapper of fat, like that of the Hog, would not have answered the purpose. "Though double the thickness to that usually found in the Cetacea, it could not have resisted the superincumbent pressure; whereas, by its being a modification of the skin, always firm and elastic, and in this case being never less than several inches, and sometimes between one and two feet thick, it operates like so much caoutchouc, possessing a density and resistance which the more it is pressed, it resists the more." §

* Some of the larger species can remain under water for a considerable time. *Vide* Naturalist's Library, vol. vii.; or article "Cetacea," Encyclopedia of Anatomy and Physiology.

† Bell.

‡ Dublin Philosophical Journal, i. p. 356, quoted by Bell.

§ Naturalist's Library, vol. vii., quoted by Bell. Above a year before we

This remarkable structure has another use; it acts like a blanket, and, being a bad conductor of caloric, prevents the animal heat from being dissipated, thus enabling these warm-blooded inhabitants of the sea to resist the cold of the medium in which they live. Nor does its utility stop even here; it is specifically lighter than the sea-water, and though its weight sometimes exceeds thirty tons, it does not act as an incumbrance, but in reality renders the animal more buoyant.

Thus provided, the Rorqual, of ninety or a hundred feet in length, the largest of all Whales, and consequently of all existing animals, can propel its enormous bulk through the water, or float at ease upon the surface. To such a being how appropriate and how beautiful are the words of Milton:—

> ——————"That sea-beast,
> Leviathan, which God of all his works
> Created hugest that swim the ocean stream:
> Him, haply, slumbering on the Norway foam,
> The pilot of some small night founder'd skiff,
> Deeming some island, oft, as seamen tell,
> With fixed anchor in his scaly* rind,
> Moors by his side under the lee, while night
> Invests the sea, and wished morn delays."
>
> PARADISE LOST, Book 1.

met with this extract, we had an opportunity of examining a Hyperoodon or Bottle-head Whale, taken in Belfast Bay. One of the captors had inflicted a wound on the back with a hatchet, and the dark skin and light coloured blubber underneath we could compare to nothing but a newly-cut cake of caoutchouc. In firmness and elasticity, when pressed by the finger, the resemblance seemed not less perfect,

* It is almost needless to say that the skin is not "scaly." In the works of Gesner, 1588, there is the figure of a vessel anchored to a Whale; so that the poet has given expression to what was at one time the current belief.

Order CARNIVORA.—FLESH-EATING ANIMALS.



Fig. 325.—Leopard.

——————"The Tiger, darting fierce
Impetuous on the prey his glance has doom'd:
The lively-shining Leopard, speckled o'er
With many a spot, the beauty of the waste;
And scorning all the taming arts of man."—Thomson.

In this order Cuvier included insect-eating animals, whether, like the Bat, they pursued their prey in the air, or, like the Hedgehog, sought for it on the earth. But each of the animals just named is now the representative of a distinct order, and the term carnivora is restricted to those which live principally upon the flesh of other vertebrate animals, and in popular language are termed beasts of prey.

Taking the family of the Tiger as that in which the characteristics of the order are most fully developed, we find strong retractile claws, and teeth eminently fitted for cutting and tearing flesh. In that of the Bear, the light elastic step has given place to a heavy gait,* and the teeth are adapted for a

* They walk upon the sole of the foot; and the term *Plantigrade*, Lat. *planta*, a sole; *gradus*, a step, has therefore been applied to all which progress

diet consisting partly of flesh and partly of vegetables. In the seals, which are aquatic carnivora, the body is fish-shaped, and the extremities are modified in form, and present the appearance of paddles, fitted to propel the animals with velocity through the water, in pursuit of their finny prey.

The order presents, therefore, great diversity of form among its members, and includes a considerable number of species. They amount, according to Berghaüs and Johnston, to 239, which are widely distributed, but are in general most abundant in tropical countries. They have been arranged in five families.

I. *Phocidæ*.—The first is that of the Seals (*Fig.* 326).



Fig. 326.—Seal.

Like the *cetacea*, they are warm-blooded mammalia, living in the sea; but they are at once distinguished from them by the absence of the broad, flat, horizontal tail, the presence of the four fin-shaped feet, and other peculiarities. Their great haunt is the sea of the arctic regions, and the *fishery*, for so it is termed, is one of great value, both for the oil and the skins. The number of Seals annually taken has been estimated at the extraordinary number of one million.*

Four species are known on the coasts of these countries.† The most common (*Phoca vitulina*) appears to be of a docile and gentle disposition; its most usual length is from four to five feet. Other species are said to attain a length of fourteen or fifteen feet.

in that manner. The cat and others walk on the extremities of the toes, and are hence grouped under the term *Digitigrade*, Lat. *digitus*, a finger; *gradus*, a step.

* Berghaüs and Johnston's Physical Atlas.

† For details respecting their appearance and habits, *vide* Professor Bell's British Quadrupeds: R. Ball on the Phocidæ of the Irish Seas. Transactions of the Royal Irish Academy, 1838. We would add Maxwell's Wild Sports of the West. Those who have read Sir Walter Scott's Antiquary do not require to be reminded of the encounter of Hector M'Intyre and the "*Phoca*."

II. *Ursidæ*.—The Bears are remarkable for their great strength, their ponderous body, and their peculiar gait. The food of the American Black Bear is principally vegetable;* that of the Polar Bear is flesh, mostly that of the Seals. The Brown Bear (*Fig.* 327) is found in the mountainous parts of



Fig. 327.—Brown Bear.

the Continent of Europe, and was formerly a native of Britain. The remains of two other species have been discovered in England, as well as in other parts of Europe, in a fossil state; one of them, the Great Cave Bear, must have been of gigantic size.

The Badger (*Meles taxus*) is, in these countries, the only surviving representative of the present family. Fossil remains of the Badger have been found in the same localities as those of the Great Cave Bear above mentioned; and the species appears to be identical with that existing. There are even grounds for attributing it to a still higher antiquity, and for believing it to

* The fondness of this animal for honey is so well known, that Washington Irving, in his Tour on the Prairies, introduces one of the rangers as expressing himself in the following graphic, though not very elegant phraseology:—"The bear is the knowingest varment for finding out a bee-tree in the world. They'll gnaw for days together at the trunk, 'till they make a hole big enough to get in their paws, and then they'll haul out honey, bees and all."

be, to use the words of Professor Owen,* "the oldest species of mammalia now living on the face of the earth."

III. *Mustelidæ*.—The Otter, the Weasel (*Fig.* 328), and



Fig. 328.—Weasel.

the Ferret, are so well known that they may be enumerated as giving, by the slenderness and flexibility of their bodies, an idea of the characteristic structure of the group. The Otter, which lives principally upon fish, has been taught to aid the fisherman in his vocation. The Stoat (*M. erminea*), like the Alpine Hare or the Ptarmigan, changes the colour of its covering in winter to a snowy white. The fur is then in that condition in which it is most valuable, the pure white of the skin contrasting with the deep black colour of the tail. Its unsullied aspect has even become proverbial; in so much that the "ermined robe of justice" is regarded as symbolical of the mental purity of its wearer. The Ermine has been observed among the Swiss mountains at an elevation of 9,600 feet; its habitation is above the lower limit of perpetual snow, and in the region of the Alpine shrubs.†

IV. *Canidæ*.—The various races of the domestic Dog, in all climates the friend and companion of man, belong to this



Fig. 329.—Wolf.

* British Fossil Mammalia. p. 111. † Berghaüs and Johnston.

family, and also the Fox and the Wolf. The Fox would probably have ceased to exist in these countries, but for the protection afforded to him by the sportsman. The Wolf (*Fig.* 329), less cunning and more fierce, has long since been exterminated. Professor Bell inclines to the opinion, "that the Wolf is the original source from which all our domestic dogs have sprung."*

V. *Felidæ.*—The Cat tribe includes the Lion, the Tiger, the Panther, the Leopard (*Fig.* 325), the Puma, and those other quadrupeds remarkable for their destructive powers. They serve to keep within bounds the excessive multiplication of the smaller mammalia, and are widely distributed. The Wild Cat is now the only representative of the group in these countries.

There was a period, however, when a Tiger larger than that of Bengal, and with proportionally larger paws, roamed over Europe. Its remains have been found in England, and Professor Owen speaks of it as the "Great Cave Tiger." To the very Rev. Dr. Buckland, Dean of Westminster, we owe a detailed account of a discovery even more interesting: that of a cave at Kirkdale, in Yorkshire, which had been inhabited by Hyænas.† These animals are now met with only in Asia and Africa; the species represented in the figure (*Fig.* 330), is found at the Cape of Good Hope. They live principally upon carrion, thus presenting the same analogy to the Tiger that the Vulture does to the Eagle. They also devour the remains left by other beasts of prey, and crunch the bones, which they are enabled to do by the great strength of their jaws. The teeth of Hyænas found in the cave at Kirkdale, give evidence, Dr. Buckland states, of the existence of two or three hundred individuals. They belong to an extinct species first made known by Cuvier, and exceeding in size the largest species of Tiger. The whole extent of the floor of the Kirkdale cavern was strewed with bones of different animals,



Fig. 330.—Spotted Hyæna.

* British Quadrupeds, p. 200.

† Reliquiæ Diluvianæ.

broken and splintered, and bearing evidence of the action of jaws which, even in the more diminutive species at present existing, are known to be sufficiently powerful to bite off the leg of a dog at a single snap. From the facts which his researches elicited, Dr. Buckland infers, that the cave must have been for a long series of years the residence of Hyænas, and that they dragged into its recesses the other animal bodies, the remains of which are found mixed indiscriminately with their own.

It is a strange tale that within the caves of Yorkshire, and other English localities, those powerful beasts had dwelt, and at night had roamed abroad and sought their prey; and no less strange are the facts brought to light by the examination of the remains of those animals on which they fed. They consisted of the Great Cave Bear and Tiger, the Mammoth, Rhinoceros, Hippopotamus, the "Irish Elk," wild oxen of colossal size, and other mammalia belonging to an extinct Fauna.*

We speak of the brevity of life, but our language applies to the life of an individual. Let us expand our thoughts, and reflect on the brevity of life assigned, not to an individual, but to a species. Here several quadrupeds are named, all large and powerful, yet not one of them has left a descendant among living tribes.† They lived their appointed time, performed their allotted work, then passed away, and have been succeeded by other species whose structure is no less perfect, and who fulfil no less efficiently what is given them to do.

The question naturally arises, how the various members of the ancient Fauna came into one small island? The answer given by those who have most attentively studied the evidence bearing upon the subject is, that these countries were not at that time separated from the continent of Europe. The geological structure, the fossil remains, and the existing Flora, all testify the same fact, and render the conclusion irresistible.‡

* Of what geologists call "the newest tertiary and drift periods."

† Mr. Lyell was the first to make known the remarkable fact, that the "longevity of the species in the mammalia is, upon the whole, inferior to that of the testacea."—Principles of Geology, vol. iv.

‡ On this subject we would refer to the original and valuable Essay of Professor Edward Forbes, in the first volume of the Memoirs of the Geological Survey of Great Britain; to the Introduction to Professor Owen's Fossil Mammalia; and to an able review of the state of our knowledge upon the subject, in the anniversary address of the President of the Geological Society, Leonard Horner, Esq. F.R.S., 19th Feb. 1847.

Order INSECTIVORA.—INSECT-EATING ANIMALS.

"Pray you tread softly that the Blind Mole may not
Hear a foot fall."—Shakspeare.

The teeth of the Insectivora, raised into pointed and conical summits, furnish another example of the adaptation of the teeth to the nature of the food on which they are designed to act. This order is represented among British animals by the Shrew, the Hedgehog, and the Mole.



Fig. 331.—Shrew.*

Soricidæ.—The general appearance of the Shrew (*Fig.* 331), is well indicated by its popular name of "Shrew Mouse." It frequents the field and the garden, rooting with its long and tapering snout for insects and worms. The Water Shrew is not found in Ireland.

Erinaceadæ.—The common Hedgehog (*Erinaceus Europæus, Fig.* 332) is, as its scientific name imports, widely distributed over Europe. It is unable to defend itself by force, or to seek safety in flight; yet by its peculiar covering it is "endowed with a safeguard more secure and effectual than the teeth and claws of the Wild Cat, or the fleetness of the Hare." Idle stories of its robbing orchards, and carrying off the apples upon its spines, are yet current in Ireland. At the time we last heard the tale, the innocent object of the slander was in the house, crunching, with much apparent relish, the Common Bandel Snail (*Helix nemoralis*), in its shell—a group of merry children having collected from about the hedgerows a large plateful of the Snails as a supper for their prickly favourite.

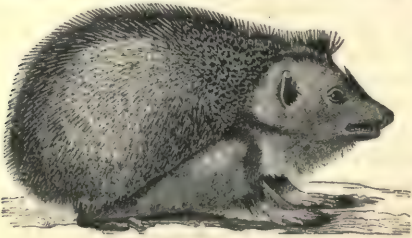


Fig. 332.—Hedgehog.

Talpidæ.—The Mole (*Talpa vulgaris, Fig.* 333) is not

* The species represented is the *Musaraigne* of the French authors, and, according to Professor Bell, identical with the common Shrew of England (*Sorex Araneus*). The common Shrew of Ireland is the *Sorex rusticus* of Jenyns.

found in any part of Ireland. It has no external ears, and the eyes are so extremely minute that in popular language it is always spoken of as "blind."* The broad forefeet with the palms turned outwards, and so admirably adapted for digging, are the most striking characteristic. The food consists of insects and worms, though vegetable matters are occasionally found in the stomach, because Moles gnaw the roots of plants for the purpose of extracting larvæ and worms. They do not become dormant during the winter, so that the necessity of exertion to obtain the needful supply of food is continual

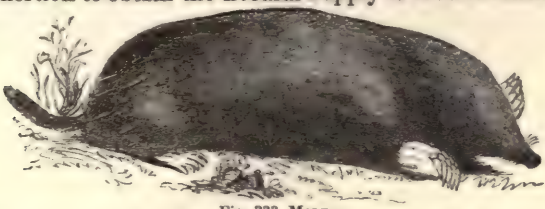


Fig. 333. Mole.

To the superficial observer, the Mole—"blind, awkward, and shapeless," condemned to a life of toil in subterranean darkness—is an object of pity. To the naturalist it affords another proof "of the wisdom and beneficence of the Creator, which can render a life so apparently incompatible with comfort, in reality one of almost incessant enjoyment."

"Its feeding and its habitation, its wanderings and its repose, its winter retreat, and the nest in which its young are brought forth and nourished, are all so many calls for the most laborious and enduring toil; but on the other hand, that toil is so amply provided for in the whole structure of the animal, so exactly balanced by the strength and conformation of its limbs, that it cannot be considered as exceeding the healthful, and even pleasurable, exercise of its natural powers."

The words we have just quoted are those of Professor Bell. We use them because we would wish to introduce to the reader the complete and interesting exposition of the habits and economy of the Mole, given by that eminent zoologist, in his History of British Quadrupeds: from that work, by the kind permission of its author, our representation of the animal has been copied.

* There is another species, *T. cæca*, in which the eyelids are closed; both are inhabitants of Europe.

Order CHEIROPTERA.—BATS.

"The bat that with hook'd and leathery wings
Clung to the cave roof."—Southey's "Thalaba," book ix. st. 30.



When we see the Common Bat (*Vespertilio pipistrellus*) flitting about after its insect prey in the dusk of the summer evening, we at once recognise it as an insectivorous animal, adapted for capturing its food in the air instead of on the earth. We then are naturally led to inquire by what means



Fig. 334.—Skeleton of Bat.*

* Fig. 334. Skeleton of a Bat.—*cl*, clavicle; *h*, humerus; *ul*, ulna; *ca*, carpus; *po*, thumb; *mc*, metacarpus; *ph*, phalanges; *o*, scapula; *f*, femur; *ti*, tibia. The several bones are indicated by the same letters as in the skeleton of the Camel, *Fig.* 289

is this effected—what is the mechanism by which the power of flight is given to the Bat? It is furnished with wings. Do they resemble those of the bird? They are altogether unlike, differing not only in the absence of feathers, but in their entire structure. In birds the feathers are principally attached to bones which correspond with those of our arm. But to compare the bones of the Bat's wing with those of the human frame, let us suppose the skeleton of a man with the fore-arm gently prolonged, and the fingers about a yard and a-half in length. The bones would then form a framework analogous to that of an umbrella, and capable like it of being shut up or expanded. Let us suppose this bony framework covered with some light and pliant material, which is continued between the legs and down to the ankles, and we would then have a figure resembling in the organs of flight that which is in reality possessed by the Bat, and which is represented in the accompanying figure (*Fig.* 334). The bones of the fingers constitute the framework of the wing, and hence the term *Cheiroptera*,* or "hand-winged," is that by which the order is designated. The thumb does not partake of this extraordinary development; it remains free, and is furnished with a hooked nail.

If a Bat be placed on the smooth surface of a table, its awkward attempts at walking (*Fig.* 335), give an idea of helplessness akin to that which was suggested to naturalists when the Sloth was seen upon the ground. Yet compassion in both cases would be alike misplaced. Each animal is gifted with powers of locomotion adapted to its wants. The Bat can climb with ease the rugged and perpendicular surface of a tree, or can wheel its flight in the air, though burthened with one or two young adhering to its teats.

The use of the wings does not seem to be limited to that of flight. They appear to be endued with a most delicate sense of touch, a sense so exquisitely fine as to be affected by the slightest difference in the vibrations of the air. By the cruel



Fig. 335.—Bat Walking.

* From the Greek words meaning "a hand" and "a wing."

experiments of Spallanzani, it was proved that Bats deprived of sight could fly without striking against walls or other objects, and were even able to avoid coming into contact with threads placed across the apartments in various directions.

Many tribes of Bats have curious leaf-like appendages upon the nose (*Fig.* 336), and these are supposed to be organs of a sense of smell not less susceptible. The presence or absence of this leaf-like organ, and its various modifications, supply naturalists with a good external character for distributing these animals into different groups. In the true Bats which are common in these countries these foliated appendages are altogether wanting.



Fig. 336.—Head of Vampire.

Only three species of Bats have as yet been recorded as natives of Ireland;* while eighteen are known in the sister country. In tropical countries the number is much more considerable, some species living upon insects, and some on fruits. There are in all 219 species.

The teeth of the Vampire Bat are exhibited in the annexed figure (*Fig.* 337); and with such weapons it is easy to imagine



Fig. 337.—Skull and Teeth of the Vampire Bat.†

how they can inflict a wound and suck the blood. But their powers seem to have been much exaggerated. Mr. Darwin says, in speaking of the Vampire Bat of South America, which bites the horses on their withers—"The injury is generally not so

* Thompson's Report. A fourth is said to have been since obtained.

† Fig. 337.—*a*, profile of the head; *b*, front view of incisor and canine teeth.

much owing to the loss of blood as to the inflammation which the pressure of the saddle afterwards produces."*

Some Bats are of considerable dimensions. There is one species in the island of Java (*Pteropus Javanicus*), the expanse of whose wings is so much as five feet. It is probable that some of the large Indian Bats, with their predatory habits and obscure retreats, may have suggested to Virgil the idea of the Harpies, "which fell upon the hastily-spread tables of his hero and his companions, and polluted, whilst they devoured, the feast from which they had driven the affrighted guests."†

Order QUADRUMANA.—MONKEYS.

"Meddling Monkey—busy Ape."—Shakspeare.

Those who have visited a zoological garden, or a well-stocked menagerie, cannot fail to have been amused at the freaks and gambols of the monkeys; and after watching for a time their agile movements and grotesque attitudes, must have been struck with the peculiar formation of the extremities, both of the feet and of the paws. The feet are not shaped like ours, but resemble hands, being furnished with fingers and with thumbs. In fact, they do not perform the functions of feet only, but of hands also. Hence that order to which the Monkeys belong is termed *quadrumana*, or four-handed.

We are not, however, to suppose that every individual belonging to this group possesses both on hands and feet a thumb which can be applied or opposed to each of the fingers. The American Monkeys, for example, are by this single circumstance distinguished at once from those of the Old World. They have the full power of using the thumbs which are on the feet, but not those which are on the anterior extremities. By such differences, and by those in the dentition, the presence or absence of cheek pouches, and other peculiarities, the order is subdivided into families, genera, and species.

We shall briefly notice the Lemurs of Madagascar, the Monkeys of America, and those of the Old World.

* Voyages of the Adventure and Beagle, vol. iii. p. 25.
† Bell's Quadrupeds, p. 9.

"The Lemurs," says Mr. Bennett, "are all natives of Madagascar, and one or two smaller islands in its neighbourhood. We know but little of their habits in a state of nature; but they are said to live in large bands upon the trees, feeding principally upon fruits; and their conformation renders this account extremely probable. They are almost equally agile with the Monkeys, but are much more gentle and peaceable in their dispositions."* It will be seen, from the accompanying figure (*Fig.* 338), that both extremities are furnished



Fig. 338.—White-fronted Lemur and its Young.

with a thumb, which acts in a direction opposite to that of the fingers.

* Gardens and Menageries, vol. i. p. 147.

In this respect they contrast with the Marmozet or Oustiti, one of the American Monkeys, whose thumb, as exhibited in the annexed figure (*Fig.* 339), acts in a line with the other



Fig. 339.—Oustiti.

fingers, and whose nails are particularly sharp and crooked. Its principal habitat is Brazil. Other species, known as Howlers, Spider-monkeys, Weepers, and similar names expressive of peculiarities of structure or habit, are scattered throughout the warmer portions of the American continent. In the midst of the trackless forests lying between the Oronoko and the Amazon, they are particularly numerous, dwelling amid the branches of the trees, and adding insects, lizards, the eggs and young of birds, to their usual food of fruits and vegetables. In many of them the tail becomes an instrument of prehension (*Fig.* 340), by the aid of which they can pass in security from tree to tree, or swing in full activity suspended from the branches. For all animals which have opposable thumbs upon the feet, but not on the anterior extremities, Mr. Ogilby proposes the term *Pedimana*, or "foot-handed."

The Monkeys of the Old World, like those of the American continent, are limited to the torrid regions, and are therefore natives of Asia and of Africa. To this there is only one exception, a colony of the Barbary Baboon (*Papio inuus*), occupying a part of the rock of Gibraltar, and appearing to flourish in the elevated solitude of that mighty fortress.

In Asia there are species which are not only free from molestation, but which have been deified by the Hindoos. "Splendid and costly temples are dedicated to these animals; hospitals are built for their reception when sick or wounded; large fortunes are bequeathed for their support; and the laws

of the land, which compound for the murder of a man by a trifling fine, affix the punishment of death to the slaughter of a Monkey."* The species thus referred to, the Entellus,



Fig. 340.—WHITE-THROATED SAJOU.

or Hoonuman, though a native of the hot plains of India, is found on the Himalaya Mountains, so far as the wood extends, or to the height of thirteen thousand feet.†

The Monkeys (*Simiadæ*) of the Old World are distinguished, in common phraseology, by the names of Apes, Monkeys, and Baboons: "a division which has the rare advantage, seldom attendant upon mere popular classifications, of being in perfect accordance with scientific principles, founded upon the structure and habits of the animals."

The Baboons have capacious receptacles, or cheek pouches, in which they stow their food. They have on the hinder extremities hard places, or, as they are termed, *callosities*, which are not covered with hair; the tails are short, or re-

* Library of Entertaining Knowledge. Natural History of Monkeys, Opossums, and Lemurs, vol. i.—A most entertaining and valuable work, to which we refer the reader for details which are incompatible with our limited plan.

† Berghaüs and Johnston.

duced to tubercles, and destitute of all muscular power. The Baboons go on all-fours, live among rocks and mountains, and in some cases, when they associate in troops, are more than a match for the fiercest beasts of prey. "They are arranged in two genera (*Papio* and *Cynocephalus*), respectively confined, with one or two exceptions, to the continents of Asia and Africa." "The lofty mountains of Abyssinia and of South Africa are tenanted by numerous troops of these animals (*Cynocephals*), which even appear to prefer the more rigorous climate of these elevated regions to the hot and sultry forests of the lower plains."

The Monkeys also have cheek pouches and callosities, but their tails are long and muscular, and they are pre-eminently a sylvan race. They walk on all-fours, and their long tails become powerful and efficient instruments in guiding their movements, and in maintaining, like the pole of the rope-dancer, their equilibrium during their rapid and varied evolutions. The face presents in different species a great diversity of colour, being white or black, blue or red, flesh or copper-coloured; and, added to their grimaces and imitative propensities, gives to them in our eyes the fantastic appearance that has become proverbial.

The Apes have neither tails nor cheek pouches; and the callosities mentioned exist only in a rudimentary form, or are altogether wanting. Their pace is semi-erect, and in their native woods they walk on two legs even along the branches, their long arms compensating for the want of a tail in steadying and directing their motions. With the exception of the Chimpanzee of Western Africa (*Fig.* 341), they are limited to the great islands of the Indian Archipelago. The various anecdotes which are related of the Chimpanzee and the Orang Outan evince on the part of



Fig. 341.—Chimpanzee.

these animals a superior degree of intelligence and docility. In them the philosopher will find the nearest approach to man, both in mental characteristics and bodily configuration, which the lower animals are permitted to attain; yet vast and impassable is the barrier of separation.

The Monkeys, so far as they are known at the present time, contain in all 170 species, forming the one-ninth of all mammalia. Their fossil remains have been found in France, in India, and in South America. They have also occurred in England; so that there is no doubt that when the climate was suitable for the Crocodiles and Turtles, whose remains occur in the London clay, and for the growth of the cocoa-nuts and spices found in the Isle of Sheppy, it was sufficiently warm for these four-handed mammalia* to enjoy their arboreal life among the branches.

To the classical scholar the present order is deserving of notice, as having given origin to the ancient fiction of satyrs, pygmies, and other supposed tribes of human monsters.

Order BIMANA.—MAN.

"Two of far nobler shape, erect and tall,
Godlike erect, with native honour clad,
In naked majesty seem'd lords of all;
And worthy seem'd; for in their looks divine
The image of their glorious Maker shone."

Paradise Lost.

Milton, in these lines, has described with the truthfulness of real poetry one of the most striking external characteristics of man—his erect gait. The zoologist points to the human hand as presenting another mark of distinction. In man only can the thumb be applied with such precision and power to each of the fingers as to seize the most minute objects. So much superior is it to the anterior extremity in Monkeys, that Sir Charles Bell remarks,—"We ought to define the hand as belonging exclusively to Man."† Of all animals, the term *Bimana*, or two-handed, is applicable to Man alone. He

* Owen's Fossil Mammalia, p. 1.
† Bridgewater Treatise, p. 18.

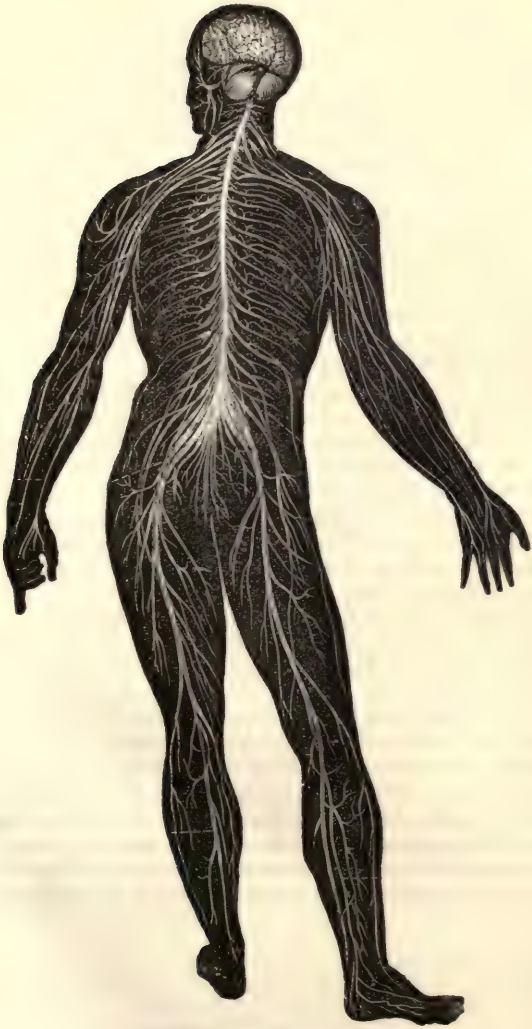


Fig. 342.—Nervous System of Man.

stands in the scale of the animal creation apart and unapproachable, gifted with dominion over "the beasts of the field, the fowl of the air, and the fish of the sea, and whatsoever passeth through the paths of the sea."

It forms no part of our design to enter into the natural history of Man. We would only point to the place he occupies, to the external characteristics by which he is distinguished, and to the hidden wonders in his bodily frame which the skill of the anatomist has revealed, in the structure of the lungs (*Fig.* 288), the circulation of the blood (*Fig.* 287), and the arrangement of the nervous system (*Fig.* 342). We leave it to the philosopher to speak of the triumph of mind in conferring on inanimate objects powers surpassing those of the fabled genii of the East; conveying the interchange of ideas with a speed outstripping that of the winds; and unveiling to the eye in the starry heavens glories to which the highest imaginings of the poet had never soared. We presume not to enter on the still nobler province of the moralist or the divine. But we would remark that, in proportion to the high privileges with which Man has been endowed, is the responsibility to employ aright the talents committed to his trust. And among the fitting and proper uses of his powers, the endeavour to know something of the works of creation by which he is surrounded should hold a foremost place.

The study of the living tribes by which the earth and the waters are peopled, forms one department of that course of mental culture, to which every man, in every condition of life, should be subjected. Such study trains our perceptive faculties to action; leads us to compare, to discriminate, to generalize, and to make the acquisition of one truth, the means of ascending to another still more comprehensive. It supplies pleasant and profitable companions amid the solitude of the shore, the dell, or the mountain; brings us a rich heritage of cheerful thoughts and healthful occupations; and, above all, it teaches us to see the beneficence of the GREAT FIRST CAUSE even in the humblest of the creatures which HE hath made.

GLOSSARY,

CONTAINING

THE NAMES OF THE SUB-KINGDOMS,

CLASSES, AND ORDERS,

AND THE

SCIENTIFIC TERMS OCCURRING IN THIS WORK.*

ACALE'PHÆ, an order of rayed animals, well known by the name of Sea-nettles. They are remarkable for their gelatinous structure and their stinging powers. From the Greek *akalephe*, a nettle.

ACANTHOPTERY'GII, an order of fishes, in which the dorsal fins are supported in part by spinous rays. Gr. *acanthos*, a spine, *pteryx* a wing or fin.

ACE'PHALA, a group of molluscous animals which, like the Oyster and Scallop, are destitute of a head. Gr. *a*, without; *kephale*, the head.

AERATED, a term applied to water or other liquids when impregnated with air.

AERIAL RESPIRATION, breathing which belongs to the air, and is carried on by lungs, as distinguished from that which has reference to water, and is effected by gills.

AFFI'NITIES, a term used to denote the close relationship in points of structure existing between different animals or groups of animals. Lat. *affinis*, allied to.

AGGLU'TINATED, having the one part united to another as if glued together. Lat. *ad*, to, *gluten*, glue. French, *agglutiner*.

AG'GREGATED, collected together. Lat. *aggregare*, to gather together.

ALBU'MEN, a thick glairy substance like the white of an egg. Lat. *albus*, white.

* Some words, which strictly speaking are not scientific terms, have, by the advice of some experienced teachers, been introduced in the Glossary. And for the same reason the Greek words, whence the terms are in many cases derived, are given, not in the Greek characters, but in the ordinary Italic letters, the Greek *upsilon* being throughout represented by the letter *y*.

ALIMENTARY CANAL, that part of the intestine through which the food passes, yielding its nutritive portions to the action of certain vessels termed "absorbents." Lat. *alimentum*, nourishment.

AMBULA'CRA, a term applied to the rows of apertures in the Star-fishes and Sea Urchins, from a fancied resemblance to the straight alleys or avenues to old mansions. Lat. *ambulacrum*, an alley, a walk.

AMMONI'TES, a group of chambered shells, belonging to the Cuttle-fish tribe, and now extinct. They bear some resemblance to coiled snakes wanting the head, and take their name from a similarity in their form to that of the horns on the statues of Jupiter Ammon.

AMPHI'BIA, an order of Reptiles, which, by the possession of both lungs and gills at the same time, or at different periods, are fitted to live either on land or in water. Gr. *amphibios*, having a double manner of life.

ANALOGOUS, a term used in Zoology to denote a resemblance between two objects, or groups of objects, as distinguished from the real structural relationship denoted by affinity.

ANALOGUE, a term employed to denote the resemblance that exists between animals in a fossil state and species still living. The recent shell is said to be the analogue of the fossil.

ANALYSIS, the separation of a compound body into the several parts of which it consists. From a similar Greek word, signifying "unloosing."

ANATOMIST, one who cuts up or dissects portions of the animal frame, for the purpose of either acquiring, or communicating to others, a knowledge of their structure.

ANIMAL'CULES, those extremely small animals which are invisible to the naked eye.—See INFUSORIA.

ANNELLA'TA, a class of articulated animals in which the body, like that of the Earth-worm, is composed of a number of rings. Lat. *annulus*, a ring.

AN'NELIDS, the members of the above class. The name has the same origin.

ANNULOSE ANIMALS, those with the body formed of successive rings. Lat. *annulus*, a ring.

ANOMOU'RA, a section of crustaceous animals, distinguished, like the Hermit Crabs, by the irregular form of the tails. Gr. *anomos*, irregular, and *oura*, a tail.

ANTERIOR, Lat. that which goes before.

ANTEN'NÆ, the horns or feelers attached to the heads of insects and crustacea.

A'PODA, without feet—applied to fishes which, like Eels, have no ventral fins. Gr. *a*, without, *pous*, *podos*, a foot.

APPARATUS, the means or instruments for effecting a certain end. Lat. *apparo*, I prepare.

AP'TERA, an order of insects including all those which, like the Flea, are destitute of wings. Gr. *a*, without, *pteron*, a wing.

AQUATIC, belonging to or inhabiting the water. Lat. *aqua*, water.

ARACH'NIDA, a class of articulated animals, including Spiders, Scorpions, and Mites. Gr. *arachne*, a spider, *eidos*, form.

ARBOREAL, belonging to or connected with trees. Lat. *arbor*, a tree.

ARBORESCENT, growing like a tree. Lat. *arborescens*, same meaning.

ARTICULA'TA, one of the great groups into which the animal kingdom is divided. It includes all those orders which are distinguished by their jointed or articulated structure, such as Worms, Crabs, Insects, and Spiders. Lat. *articulus*, a joint.

ASCIDIOI'DA, an order of Zoophytes, so named from their resemblance in some points of structure to the "*ascidia*," a genus of molluscous animals with a horny covering or tunic.

ASSIMILATED, converted into the same nature as another thing. Lat. *assimilare*, to become like.

ASTEROI'DA, an order of Zoophytes. The polypes, when expanded, exhibit a star-like figure. Gr. *aster*, a star, and *eidos*, form.

A'TROPHY, wasting from starvation.

AURICLES, two of the muscular cavities of the heart of man and other mammalia. Their form bears some resemblance to an ear; hence the name, from the Latin *auris*, an ear.

AVES, birds; they constitute one of the classes of the vertebrate animals.

BALEEN, the substance commonly known as "whalebone." Lat. *balæna*, a whale.

BARNACLE, a common name for one tribe of the articulated animals, termed *cirripeda*, which are found adhering to floating timber and the bottoms of ships. The common name is derived from the Saxon, *bearn* a child, and *aac*, an oak, "child of the oak," thus expressing the belief as to their origin.

"BASIN" of Paris, "Basin" of London. "Deposits lying in a hollow or trough, formed of older rocks, and sometimes used in geology almost synonymously with 'formations,' to express the deposits lying in a certain cavity or depression in older rocks."—LYELL.

BATRACHIA, an order of reptiles, including the Toad and Frog. Gr. *batrăchos*, a frog.

BILIARY DUCT, in anatomy, a canal or vessel through which the bile flows.

BI'MANA, the order of mammalia of which man is the sole representative. Lat. *bis*, twice, and *manus*, the hand, meaning *two-handed*.

BIVALVE SHELLS are those, like the Oyster and Cockle, which are formed of two parts. Lat. *bis*, twice, *valvæ*, doors.

BRACHIO'PODA, "arm-footed," a class of bivalve molluscous animals, with long ciliated arms. Gr. *brachion*, an arm, and *pous*, a foot.

BRACHYU'RA, a group of crustaceous animals, distinguished like the Crab by the shortness of the tail. Gr. *brachys*, short, and *oura*, a tail.

BRAN'CHIÆ, the gills or respiratory organs of fishes and other aquatic animals.

BRANCHIAL, of or belonging to the gills.

BRANCHIAL SAC, a chamber in the tunicated mollusks; so termed because the blood is there exposed to the action of the air contained in the sea-water, which circulates over the interior surface of the cavity. Lat. *branchia*, a gill.

BRONCHIAL TUBES, the small branches of the wind-pipe. Gr. *brogchos* (pronounced *bronchos*), the wind-pipe.

BYSSUS, the silken fibres or "beard" seen in the Mussel and other bivalve shells. Gr. *byssos*, fine flax.

CADUCIBRAN'CHIATE, a term applied to that group of reptiles in which (like the Frog) the gills are not permanent. Lat. *caducus*, perishable, *branchiæ*, the gills.

CALCAREOUS, composed in a greater or less degree of lime.

CALLOW, unfledged; a term applied to the young birds while without feathers. Lat. *calvus*, bare or bald.

CALORIC, heat. Lat. *calor*.

CANINE TEETH, the two sharp-edged teeth which are largely developed in the dog and other carnivorous animals. Lat. *canis*, a dog.

CARAPACE, the vaulted shield or shell that protects the upper surface of the body of the Tortoises, or *chelonian* reptiles. This term is also applied to the upper covering of the crustacea.

CARBONATE OF LIME, the chemical union of carbonic acid and lime, as exhibited in limestone or chalk.

CARBONATED, combined with carbon.

CARMINE, a colouring substance of a brilliant red.

CARNI'VORA—CARNIVOROUS, terms applied to those animals which, like the Tiger, have teeth peculiarly adapted for the mastication of flesh. Lat. *caro, carnis*, flesh, *voro*, I devour.

CARTILAGINOUS, consisting of cartilage or gristle; applied to fishes that have the skeleton of cartilage, not of bone.

CAUDAL, belonging to the tail. Lat. *cauda*, a tail.

CELLULAR, composed of very minute cells. Lat. *cellula*, a little cell.

CEMENT, a substance employed in uniting bodies together. Lat. *cœmentum*.

CEPHALO'PODA, an order of molluscous animals which have their organs of locomotion arranged round the head, as in the Cuttle-fish. Gr. *kephale*, a head, and *pous*, a foot.

CERVICAL, belonging to the neck. Lat. *cervix*, the neck.

CETACEA, one of the orders of the mammalia; it includes the Whales, Dolphins, and allied animals. Gr. *ketos*, a whale.

CHEIROP'TERA, the name of the order of mammalia comprising the various species of Bats. The term is suggested by the peculiar structure of the wings, which consist of a membrane extended over bones corresponding to those of the fingers. Gr. *cheir*, a hand, *pteron*, a wing.

CHEMICAL, anything relating to Chemistry—that science which determines the constituents of bodies, and the laws which regulate their combinations.

CHRY'SALIS, the second or pupa state of an insect. Some species exhibit at this time brilliant metallic tints; hence the origin of the term, from Gr. *chrysos*, gold. Chrysalids is used as an English noun in the plural number, to denote more than one chrysalis.

CILIA, minute hair-like organs, which in the infusoria and polyps become important organs for locomotion, and for the capture of food by means of the currents caused by their vibration. Lat. *cilia*, eye-lashes.

CILIOBRACHIA'TA, an order of polyps, in which the tentacula or arms, surrounding the mouth, are covered with *cilia*. Lat. *cilium*, an eye-lash, *brachia*, the arms.

CILIOGRADE, a group of rayed animals, like the Beröe, in which the cilia become the organs of locomotion. Lat. *cilium*, an eye-lash, *gradior*, I advance.

CIRRI, the filaments attached to the jaws of certain fishes. Lat. *cirrus*, a tendril or curl.

CIRRI'PEDA, an order of articulated animals, comprising the Barnacles and Acorn-shells. Lat. *cirrus*, a curl, and *pes*, a foot.

COCOON, the case or covering formed by an insect prior to its change into the perfect state.

COLEOP'TERA, an order of insects. It comprises the various tribes of Beetles, many of which have membranous wings concealed under the wing-covers or elytra. Hence the origin of the term, *koleos*, a sheath, and *pteron*, a wing.

COMMINUTED, broken or ground down into small parts. Lat. *comminuere*, to crumble into small pieces.

COMPLICATED, involved or formed of many parts.

CONCHOLOGY, the department of science which treats of shells. Gr. *kogche* (pronounced *conche*), a shell, and *logos*, a discourse.

CONCRETE, particles united or coagulated into one body. Lat. *concrescere*, to coalesce into one mass.

CONCENTRIC, having one common centre.

CONGEALED, hardened or frozen into ice. Lat. *congelare*, to freeze.

CONGENER, one of the same genus, but of a different species.

CONGLOMERATE, OR PUDDINGSTONE, a rock composed of water-worn fragments of rocks and shells cemented together. Lat. *conglomerare*, to heap together into a ball.

CONTRACTILE, having the power of drawing itself into small dimensions. Lat. *con*, together, *traho*, I draw.

CONVOLUTED, Lat. *convolutus*, rolled together.

CORIACEOUS, resembling leather. Lat. *coriaceus*, leathern.

CORNEA, the anterior transparent part of the globe of the eye.

COROLLA, the blossom or coloured petals of a flower. Lat. *corolla*, a little crown.

CORUSCATION, a flash or sudden gleam of light. Lat. *coruscare*, to flash, to twinkle.

CRANIUM, the skull. Gr. *kranion*.

CREPUSCULA'RIA, a term applied to the Hawk-moths and other lepidopterous insects that fly in the twilight. Lat. *crepusculum*, twilight.

CRINOID, a family of Star-fishes which have a resemblance to the form of a lily. Gr. *krinon*, a lily, and *eidos*, form.

CRUSTACEA, the class of articulated animals which includes the Crab, Lobster, and others possessed of a similar covering. Lat. *crusta*, a shell or hard covering.

CTENOID, a term applied to a group of fishes which have the edges of the scales shaped like the teeth of a comb, as in the Perch. Gr. *kteis, ktenos*, a comb, and *eidos*, form.

CYCLOBRANCHIA'TA, an order of molluscous animals of the class *Gasteropoda*, distinguished by having the gills placed round the lower edge of the body, as in the limpet. Gr. *kyklos*, a circle, and *branchiæ*, gills.

CYCLOID, a term applied to a group of fishes which have the scales with circular or smooth edges, like those of the Herring. Gr. *kyklos*, a curve, and *eidos*, form.

CYCLOS'TOMI, an order of cartilaginous fishes, which, like the Lampreys, have a circular mouth capable of acting as a sucker. Gr. *kyklos*, a circle, and *stoma*, a mouth.

CYSTIC ENTOZOON, an internal parasite resembling a delicate cyst or bladder. Gr. *kystis*, a bladder.

DECAPITATION, the act of beheading. Lat. *decapitare*, to behead.

DECA'PODA, that division of the crustacea which includes the Crab, Lobster, Crawfish, and others having ten feet. Gr. *deka*, ten, and *pous*, a foot.

DEGLUTITION, the act of swallowing. Lat. *glutio*, I swallow.

DENTINE, the bony substance forming the principal component of the teeth. Lat. *dens*, a tooth.

DIBRANCHIA'TA, a numerous family of Cuttle-fish (*cephalopoda*) comprising all species which are furnished with two gills.

DIP'TERA, an order of insects composed of two-winged Flies. Gr. *dis*, two, *pteron*, a wing.

DIUR'NA, a term applied to lepidopterous insects which fly by day, as Butterflies. Lat. *diurnus*, belonging to the day.

DORSAL, belonging to the back. Lat. *dorsum*, the back.

DORSIBRANCHIA'TA, a tribe of Annelids which have the gills placed on the back. Lat. *dorsum*, the back, *branchiæ*, gills.

ECHINODER'MATA, one of the orders of radiated animals: it includes the Star-fishes and Sea-Urchins. The term is expressive of the appearance of their integument. Gr. *echinos*, a hedge-hog; and *derma*, a skin or covering.

EDENTA'TA, an order of mammalia, which comprises the Sloth and Ant-eater, animals which are either destitute of teeth, or have no incisors or cutting teeth. Lat. *edentatus*, without teeth.

EFFETE, barren, worn out. Lat. *effœtus*, or *effetus*, decayed, past work.

ELY'TRA, the sheaths or wing-covers of coleopterous insects (Beetles). Gr. *elytron*, a sheath.

ENAMEL, in anatomy, the smooth and very hard substance which in various forms is seen on the crown of the teeth.

ENCEPH'ALA, the group of molluscous animals which (like the Snail) are furnished with a head. The name refers to this distinguishing characteristic.

ENCRINITE, a name given to the "Stone-lilies," or fossil remains of the *crinoid* Star-fishes. Gr. *krinon*, a lily.

ENTOMOLOGIST, one conversant with Entomology, or the branch of science treating of insects. Gr. *entoma*, insects, and *logos*, a discourse.

ENTOMOS'TRACA, a term given to the minute freshwater crustacea and others having a flexible horny shell. Gr. *entoma*, insects, *ostrakon*, a shell.

ENTO'ZOA, an order of radiated animals composed of what are called intestinal worms. Gr. *entos*, within, *zoon*, an animal.

EPIDERMIS, the transparent membrane that forms the covering of the skin. Gr. *epi*, upon, *derma*, the skin.

EPIZOA, external parasites; an order of crustacea which particularly infest fishes. Gr. *epi*, upon, and *zoon*, an animal.

ERRAN'TES, a tribe of Annelids; their name denotes their wandering habits.

ERRATIC, wandering, irregular; not stationary nor fixed. Lat. *erro*, I stray or wander.

ESCULENT, eatable; that which may be used as food. Lat. *esculenta*, meat.

EUPHONIOUS, having a sound that is pleasing to the ear. Gr. *eu*, good or fine, and *phone*, sound.

EXHUMATION, the disinterment of that which has been buried. Lat. *ex*, out of, and *humus*, the ground.

EXUDATION, the discharge of moisture from a living body, by the pores of the skin. Lat. *ex*, out, and *sudo*, I sweat.

EXUVIÆ, the cast skins or shells of animals. Lat. *exuo*, I cast off.

FARINA, the pollen, or fine impregnating dust of the anthers of flowers.

FASCI'CULI, Lat. little bundles.

FAUNA, the animals that are indigenous to a certain country or district. The term is derived from the Fauni, or rural deities in Roman mythology.

FILAMENT, a thread or fibre; a long thread-like process. Lat. *filum*, a thread.

FISSION, that spontaneous division of the body which prevails in some of the infusory animalcules.

FISSIPAROUS, reproduction by continual division of the body. It is observed among some of the Infusoria. Lat. *fissus*, divided, *pario*, I produce.

FLORA, the plants belonging to a certain country or district.

FOLIATED, having leaves. Lat. *folium*, a leaf.

FOSSILS, the remains of animals and plants found in different geological formations. Lat. *fossilis*, anything that may be dug out of the earth.

FROND, a term applied to that part of flowerless plants resembling true leaves. Lat. *frons*, a leaf.

FRUGI'VOROUS, feeding on fruits, seeds, &c. Lat. *fruges*, fruits or corn, and *voro*, I eat.

FUR'CULUM, the bone of a fowl known as the "merry-thought." Lat. *furcula*, a little fork.

GANGLION, a knot or centre of nervous matter. An original Greek word.

GANOID, a term applied to a group of fishes, remarkable for the shining appearance of their scales. Gr. *ganos*, splendour, and *eidos*, form.

GASTERO'PODA, a class of mollusca, which (like the common Snail) have the lower surface of the body expanded into a muscular disc, that serves as an instrument for progression. Hence the term "belly-footed." Gr. *gaster*, the belly, and *pous*, the foot.

GELATINOUS, resembling jelly.

GEMMI'PAROUS, producing buds or gems. Lat. *gemma*, a bud, and *pario*, I produce.

GEMMULES, little gems or buds. Lat. *gemma*, a bud.

GENUS—plural, genera. Lat. A section consisting of one species, or a group of species of an indeterminate number, agreeing in some common characteristic.

GEOMETRIC, in accordance with the rules or principles of geometry.

GERMS, the apparent commencement or very early stage of existence in animal bodies.

GLOBULE, a little globe. Lat. *globulus*.

GLOTTIS, an organ situated at the upper portion of the larynx, and at the base of the tongue. Gr. *glotta*, the tongue.

GRALLATO'RES, an order of birds known as "waders," and remarkable in general for the length of their legs, which gives them the appearance of being mounted on stilts. Lat. *grallæ*, stilts.

GRAMINI'VOROUS, subsisting on grass. Lat. *gramen*, grass, and *voro*, I devour.

GRAPHICAL, well delineated; described so as to convey to the mind a picture of a certain scene or incident. Gr. *grapho*, I paint.

GREGARIOUS, having the habit of living together in a flock or herd. Lat. *grex*, *gregis*, a flock.

GYRATION, a turning or whirling round. Lat. *gyro*, I turn round.

HABITAT, the locality or situation in which an animal habitually lives.

HELIANTHOI'DA, an order of Zoophytes, in which the animals in their expanded state resemble compound flowers, like the sun-flower and marigold. Gr. *helios*, the sun, *anthos*, a flower, and *eidos*, form.

HEMIP'TERA, an order of four-winged insects, comprising the Field-Bugs, the Cicada, and others. The wings are partly membranous, and partly of a tougher material, a peculiarity which has suggested the name. Gr. *hemi*, half, and *pteron*, a wing.

HERBI'VOROUS, living upon herbs. The Herbivora are those animals that feed on herbaceous plants. Lat. *herba*, an herb, and *voro*, I eat.

HETEROGENEOUS, of a different kind or nature. Gr. *heteros*, different, and *genos*, a kind.

HEXAGONAL, having six sides and six angles. Gr. *hex*, six, *gonia*, an angle.

HU'MERUS, the bone between the elbow and shoulder.

HUMOURS OF THE EYE, the transparent portions consisting of what are termed the "watery," the "crystalline," and the "vitreous" humours.

HYBER'NATE, to retire into close quarters during the winter season. The Dormouse and the Marmot furnish familiar examples of hybernation. Lat. *hybernus*, belonging to winter.

HYDROI'DA, an order of Zoophytes; so called from their resemblance in some particulars to the fabled Hydra.

HY'DROGEN, a gas forming one of the component parts of water and of atmospheric air. Gr. *hydor*, water, and *gennao*, I produce.

HYMENOP'TERA, an order of insects comprising Bees, Wasps, and Ants: they are furnished with four membranous wings. Gr. *hymen*, a membrane, and *pteron*, a wing.

HYPO'THESIS, a supposition.

ICTHYO'LOGY, the department of natural history treating of fishes. Gr. *icthys*, a fish, and *logos*, a discourse.

IMA'GO, a term applied to Butterflies and other insects, when their transformations are completed, and they assume the appearance of the species in its perfect state.

IMPETUS, the force by which a body is impelled.

INCISORS, the front or cutting teeth. Lat. *incisores*, a cutting.

INCUBATION, the act of sitting as birds do on eggs, to develope the contained embryo. Lat. *incubo*, I sit.

INDI'GENOUS, produced naturally in a country; not exotic.

IN'DURATED, having become hardened. Lat. *indurare*, to make hard.

INDUCTION, an inference or general principle drawn from a number of particular facts.

INFEROBRAN'CHIATA, an order of molluscous animals, having the gills placed under the projecting margin of the mantle. The term simply means, having the gills below.

INFUSO'RIA, the class of animalcules so called from their abounding in certain animal and vegetable infusions.

INSECTA, insects. They form one class of articulated animals.

INSECTI'VORA, an order of mammalia, the individuals of which, like the Mole or the Hedgehog, feed on insects and worms. Lat. *insecta*, insects, *voro*, I devour.

INSESSO'RES, the order of perching birds. Lat. *sedere*, to sit, to rest upon.

INTEGUMENT, that which naturally invests or covers another thing. Lat. *intego*, I cover.

INTERSTICES, the spaces between objects. Lat. *interstitium*.

INVER'TEBRATE, without vertebræ. The term is applied to all those animals which in common language are destitute of a skull and backbone.

IRIDES'CENT, having colours like the rainbow. Lat. *iris*, the rainbow.

ISOLATED, detached. Italian, *isola*. Lat. *insula*, an island.

LA'BIUM, in entomology, the lower lip. The *labial palpi* in insects are the feelers attached to the lower lip.

LA'BRUM, in entomology, the upper lip.

LAGOON, a term applied to a small lake or pond of water; the word is derived from the Spanish *laguna*. Lat. *lacuna*.

LAMELLA, Lat. a thin plate or scale.

LAMELLIBRANCHIA'TA, a class of mollusca including the Oyster and other well-known Bivalves, in which the gills are in the form of membranous plates.

LARVA, the caterpillar state of an insect. Lat. *larva*, a mask.

LARYNX, in the higher vertebrate animals, the organ of voice, situated at the upper portion of the windpipe.

LENS, properly a small roundish glass, shaped like a lentile or bean. Lat. *lens*, a bean or lentile. The word is applied to both concave and convex glasses.

LEPIDOPTERA, an order of insects to which the Moths and Butterflies belong. The wings are covered with a mealy substance composed of minute scales. Gr. *lepis*, a scale, and *pteron*, a wing.

LIGAMENTS, the bonds or organs by which the various articulations of the body are held together. Lat. *ligamentum*, a band or tie.

LOBES, the rounded divisions on the edge of a leaf, and applied to portions of the animal frame of a similar form.

LOCOMOTION, the act of moving from place to place. Lat. *locus*, a place, and *motio*, a moving.

LOPHOBRANCHII, an order of fishes, in which the gills are arranged (as in the Pipe-fishes) in small tufts. Gr. *lophos*, a crest, and *branchiæ*, gills.

MACROURA, a section of ten-footed crustacea, distinguished (like the Lobster and Cray-fish) by the length of the tail. Gr. *makros*, long; and *oura*, a tail.

MAGNESIAN LIMESTONE, limestone which contains a portion of the earth magnesia.

MALACOPTERYGII, one of the great sections into which the osseous fishes are divided. The rays of the fins are soft, and in general branched. Gr. *malakos*, soft, and *pteryx*, a wing. It is subdivided into three orders, Abdominales, Subbrachiales, and Apodes.

MAMMALIA, the class of vertebrate animals: it includes all those that suckle their young. Lat. *mamma*, a teat.

MAMMIFEROUS, having breasts or teats for the nourishment of the young by means of milk. Lat. *mammæ*, teats; and *fero*, I bear.

MANDIBULÆ, or MANDIBLES, organs for chewing. Lat. *mando*, I chew. Applied to the upper jaws of insects

MARINE, belonging to the sea. Lat. *mare*, the sea.

MARSUPIA'TA, an order of mammalia containing the marsupial or pouched animals. Lat. *marsupium*, a pouch.

MAUSOLEUM, a sepulchral building. The name is derived from one of extraordinary magnificence erected 353 B. C. to the memory of Mausoleus, king of Caria.

MAXILLÆ, the jaws. In entomology, the term is applied to the lower jaws of insects.

MEDULLARY, resembling marrow. Lat. *medulla*, marrow. The term is used in speaking of the substance that unites the various parts of the sertularian Zoophytes into one living mass.— *Vide* "Sertularian."

MEGATHERIOID ANIMALS, a group consisting of extinct species of the order *Edentata*. The name is derived from one of colossal size, the *Megatherium*. Gr. *megas*, great, and *therion*, a beast.

MEMBRANOUS, consisting of membrane.

METAMORPHOSIS, transformation; change of shape. The word is taken from the Greek.

MICROSCOPIC, visible only by means of a microscope or magnifying glasses.

MIGRATION, change of residence; removal from one locality to another. The term is applied to those periodical changes of abode observable in many species of birds and other animals.

MILLIPEDES, insects possessed of numerous legs, and belonging to the order Myriapoda.

MILT, the soft roe or spawn of the male fish; it is used to fecundate the pea or roe of the female.

MOLARS, the grinding teeth. Lat. *molaris*, grinding.

MOLECULES, a term derived from the French, and expressing very minute particles of matter.

MOLLUSCA, one of the great groups into which the animal kingdom is divided. It contains the soft-bodied animals popularly known as "shell-fish." Lat. *mollis*, soft.

MONAD, an atom that admits of no further subdivision. Gr. *monas*, a unit.

MONOGRAPH, a written description of a single thing, or class of things. Gr. *monos*, one, and *grapho*, I write.

MOULTING, the periodical change that takes place in the plumage of birds.

MUCUS, slime, or slimy matter.

MULTIVALVE, a term applied to shells which (like the Chiton) consist of more than two valves.

MYRIA'PODA, an order of insects consisting of those which (like the Centipede and Millipede) have numerous feet. Gr. *myroi*, ten thousand, innumerable, and *pous*, a foot.

NATATO'RES, the order of swimming birds. Lat. *nato*, I swim.

NEUROPTERA, an order of four-winged insects, in which what are termed the "nervures" of the wings are so disposed as to form a kind of network (as in the Dragon-fly). Gr. *neuron*, a nerve, and *pteron*, a wing.

NEUTERS, a name given to the working Bees, to distinguish them from the males and females of the hive.

NICTITATING MEMBRANE, that which is called the third eyelid in birds.

NUDIBRANCHIATA, an order of mollusks in which the gills are naked or exposed (as in Eolis, *Fig.* 164.) Lat. *nudus*, naked, *branchiæ*, gills.

OCELLI, little eyes. Lat. *ocellus*, a little eye.

ŒSOPHAGUS, the gullet.

OLFACTORY, smelling, or having the sense of smell. Lat. *olfacere*, to smell.

OMNI'VOROUS, eating food of every kind. Lat. *omnis*, all, and *voro*, I devour.

OPHIDIA, that order of reptiles under which all serpents are included. Gr. *ophis*, a snake.

ORGANIC, consisting of parts made to co-operate with each other, as in those which constitute the bodies of plants or animals.

ORGANIC REMAINS, the remains of animals or plants (*organized* bodies) found in a fossil state.

ORGANS, the parts or instruments by which certain objects are effected. Lat. *organum*, a machine or instrument.

ORTHOCE'RATITES, a name given to a group of large chambered fossil shells, which are straight and tapering. Gr. *orthos*, straight, and *keras*, a horn.

ORTHOP'TERA, an order of four-winged insects, in which the wings are longitudinally folded when at rest, as in the Cricket and Grasshopper. Gr. *orthos*, straight, and *pteron*, a wing.

OSSEOUS FISHES, those that have the skeleton of bone. Lat. *os*, a bone.

OTOLITES, the ear-bones of fishes. Gr. *ous*, *otos*, the ear.

O'VARIES, OVISACS } receptacles for the eggs or ova.

OVI'GEROUS VESICLES, the little bladders or cells in which the ova or germs of some Zoophytes are observed. Lat. *ova*, eggs, and *gero*, I bear or carry.

OVIPAROUS ANIMALS, those whose young are produced from eggs. Lat. *ovum*, an egg, and *pario*, I bring forth.

OVIPOSITOR, the instrument by which eggs are deposited. It is remarkable for its great length in some species of insects.

OVO-VIVIPAROUS ANIMALS are those in which the egg is ruptured in the act of deposition, and the young are brought forth alive.

OXYGEN, a gas which is one of the constituent parts of water, and of atmospheric air; it is essential to animal life.

PACHYDERMATA, an order of quadrupeds, including the Elephant, and other animals distinguished by having thick skins. Gr. *pachys*, thick; and *derma*, the skin or hide.

PALPI in insects, the organs popularly termed "feelers." Lat. *palpum*, a gentle touch or pat.

PAPILLÆ, small projections or protuberances which resemble in form the nipple or the teats of animals. Lat. *papilla*, a nipple.

PARASITA, animals that are parasitic, or draw their support from the bodies of other animals to which they attach themselves. Lat. *parasitus*, a parasite or hanger-on.

PECTINATED, shaped like a comb. Lat. *pecten*, a comb.

PECTINIBRANCHIATA, an order of mollusks in which (as in the *Buccinum* and the *Murex*) the gills are shaped like the teeth of a comb. Lat. *pecten*, a comb, *branchiæ*, gills.

PECTORAL, belonging to the chest. Lat. *pectus, pectoris*, the chest.

PEDI'MANA, "foot-handed"—a term applied to some of the monkey tribes that have opposable thumbs on the feet, but not on the anterior extremities, or, as they are usually termed, "the hands."

PEDUNCLE, in Botany, the stalk that supports the flower; in Zoology, it is employed—as is also the word Pedicle—to denote a small stalk or stem; thus many of the crustacea have eyes mounted on foot-stalks or peduncles. Lat. *pes*, a foot.

PEDUNCULATED, having a stem or foot-stalk.

PERENNIBRANCHIATE, that group of amphibious reptiles in which the gills are permanent. Lat. *perennis*, permanent or lasting, and *branchiæ*, gills.

PETALS, the leaves composing the *corolla* or blossom of a flower. Gr. *petalon*, a leaf.

PETRIFIED, converted into stone. Lat. *petra*, a stone, and *fieri*, to become.

PHARYNX, the upper portion of the windpipe.

PHENOMENON, literally that which may be seen; generally used to imply some striking or remarkable appearance. Gr. *phaino mai*, I appear.

PHOSPHORESCENCE, the light caused by phosphorus; very conspicuous and brilliant in some of the soft-bodied marine animals.

PHYLLO'PHAGOUS, "leaf-eating"—a term applied to the Sloths and other animals of the same order. Gr. *phyllon*, a leaf, and *phago*, to eat.

PHYSIOLOGIST, one conversant with the laws of animal economy, or that knowledge which is denoted by the word "Physiology." Gr. *physis*, nature, and *logos*, a discourse.

PIGMENTAL CELLS, those which contain the colouring materials or pigments which give to the skin its peculiar tints.

PINNÆ, wings or pinions. The term is applied to the wing-like expansions of certain Zoophytes. "Pinnated," in Botany, means leaves that grow in pairs or like wings, from the leaf-stalk, as in the Ash or the Rose; and in Zoology, it is used to denote a wing-like appearance.

PISCES, fishes—one of the classes of vertebrate animals.

PLACENTA, a network of blood-vessels by which the young of most mammalia are nourished prior to birth.

PLACOID, a term applied to a group of fishes having scales of a broad flat form. Gr. *plax*, a broad flat surface, and *eidos*, form.

PLAGIO'STOMI, the order of cartilaginous fishes which includes the Sharks and Rays. Gr. *plagios*, slanting, and *stoma*, a mouth.

PLASTRON, a term applied to the shell or plate that covers the lower surface of the body of the Tortoise.

PLECTOGNATHI, an order of osseous fishes in which the jaws are united, as in the Globe-fish and Trunk-fish. Gr. *plektos*, plaited, and *gnathos*, the jaws.

POLLEN, the farina or fine dust contained in the anthers of flowers.

POLYGA'STRICA, one of the great divisions of the Infusory animalcules, characterised by the possession of a number of sacs or stomachs for the reception of food. Gr. *polys*, many, *gaster*, the belly.

POLYGONAL, having many angles and sides. Gr. *polys*, many, and *gonia*, an angle.

POLYPES, rayed animals which were formerly supposed to partake of the nature of both plants and animals. The tentacula when expanded bear some resemblance to the arms of Cuttle-fishes, known to the ancients as *Polypi;* hence the origin of the name.

POLY'PIDOM, the horny sheath with which the soft body of the Polypes is invested. Lat. *polypus*, a polyp, and *domus*, a house.

PREHENSILE, having the power of seizing. } Lat. *prehendere*, to
PREHENSION, the act of seizing. } take, seize, or catch.

PRIMARIES, the terminal feathers of the wings of birds. They grow on the parts which correspond to the bones of our hands.

PRISMATIC COLOURS, the beautiful rainbow tints produced by the refraction of a ray of light by means of a prism.

PRIME'VAL, belonging to the first or earliest ages. Lat. *primum ævum*, the first time.

PROBOSCIS, a fleshy prolongation of the snout, as seen in the Tapir, or in the trunk of the Elephant.

PROCESS, an anatomical term meaning a projecting portion. In this sense, it has a different signification from the same word as used in arts and manufactures.

PROPAGATION, the continuance of species; the generating of young individuals from the parent stock. Lat. *propagare*, to multiply or increase.

PRO'TOTYPE, the first or original form or model. Gr. *protos* first, *typos*, impression. In Zoology, the term is applied to a species in which the characteristics of the group to which it belongs are well developed.

PTERO'PODA, a class of mollusca which have two membranous expansions like fins or wings, and are hence spoken of as "wing-footed." Gr. *pteron*, a wing, and *pous*, a foot.

PULMONARY, pertaining to the lungs. Lat. *pulmo*, a lung.

PULMONATA, the order of mollusks which breathe by lungs; the common Slugs and Snails are well known examples of the tribe.

PULMO'NIGRADES, the numerous tribes of Medusæ or Jelly-fishes, which move by the contraction and expansion of the disc, and respire by the effects of the same movement. Lat. *pulmo*, a lung, and *gradior*, I walk or advance.

PUPÆ, insects in that state which immediately precedes their appearance in their perfect or *Imago* form.

QUADRU'MANA, the order of mammalia which includes the Apes and Monkeys. *Quadrus*, a derivation of the Latin word for four, and *manus*, a hand, as the four feet of these animals may in some degree be used as hands.

QUADRUPEDS, four-footed animals—*quadrus*, from *quatuor*, four, *pes*, *pedis*, a foot. The term is restricted to those that suckle their young; or, in other words, to the class *mammalia*.

QUARRY, the prey at which a hawk is flown.

RADIAL LINES, those which extend from the centre of the Spider's web to the circumference, thus forming the *radii* of the circle.

RADIA'RIA, that division of the Rayed animals in which the radiated structure is most conspicuous, as in the Star-fishes and Jelly-fishes.

RADIATED ANIMALS, or *Radiata*, one of the primary groups into which the animal kingdom is divided. In them the nervous system, so far as it has been observed, presents a rayed or radiated arrangement.

RAMIFICATION, extending or branching out in the manner of the branches of a tree. Lat. *ramos facere*, to make branches or boughs.

RAPTO'RES, an order of birds which includes the Falcons, Owls, and other birds of prey. Lat. *raptor*, one who seizes, drags, or takes away by force.

RASO'RES, the order of "scraping birds." It includes the Hen, the Turkey, and other barn-door fowl. Lat. *rasor*, one who scrapes.

RETICULATED, presenting the appearance of network. Lat. *rete*, a net. The wing of the Dragon-fly is of this kind.

RETRACTILE, capable of being drawn back. Lat. *retrahere*, part. *retractum*, drawn or pulled back.

RODENTIA, the order of mammalia known as the "gnawing" animals, including the Hare, the Rat, and the Squirrel. Lat. *rodere*, to gnaw.

ROE or PEA, the name given to the mass of the ova of fishes.

ROTI'FERA, one of the two great divisions of the infusory animalcules. Their name is derived from certain appendages which present an appearance resembling that of wheels in rapid motion. Lat. *rota*, a wheel, and *fero*, I bear.

RUMINAN'TIA, that order of mammalia which includes the Ox, the Sheep, and other animals that chew the cud. Lat. *ruminare*.

SACCHARINE, sugary; having the properties of sugar. Lat. *saccharum*, sugar.

SAURIA, an order of Reptiles, comprising the various tribes of Lizards. Gr. *saura*, a lizard.

SCANSORIAL, climbing. Lat. *scandere*, to climb.

SCUTIBRANCHIA'TA, an order of molluscous animals which have the gills protected by a shield. Lat. *scutum*, a shield, *branchiæ*, gills.

SECONDARIES, the feathers belonging to the wings of birds, and which grow on the bones corresponding to those of the fore-arm, or that part between the wrist and the elbow.

SECONDARY ROCKS, "an extensive series of the stratified rocks which compose the crust of the globe, with certain characters in common, which distinguish them from another series below them, called *primary*, and from a third series above them, called *tertiary*."—LYELL.

SEDENTARY, remaining at rest, motionless, inactive. Lat. *sedentarius*, from *sedere*, to sit.

SERTULARIAN ZOOPHYTES, those which bear a resemblance to miniature plants or flowers. Lat. *sertula*, a little nosegay, wreath, or chaplet of flowers.

SESSILE, sitting; used sometimes in contradistinction to pedunculated: thus the eyes of some crustacea are *sessile*, while those of others are said to be *pedunculated*, or on foot-stalks.

SILEX, the earth entering into the composition of flints.

SILICEOUS, flinty; principally composed of the earth silex.

SPIRACLES, Lat. *spiraculum*, a breathing-hole.

STERNUM, the breast-bone, or the flat bone occupying the front of the chest.

STRATA, STRATUM.—"The term stratum, derived from the Latin verb *sterno*, to strew or lay out, means a bed or mass of matter spread out over a certain surface by the action of water, or in some cases by wind. The deposition of successive layers of sand and gravel in the bed of a river, or in a canal, affords a perfect illustration both of the form and origin of stratification."—LYELL.

STREPSIP'TERA, an order of insects consisting of the family of the Stylops. The term is derived from the Greek *strepho*, to twist, and *pteron*, a wing; the first pair of wings being absent, and represented by twisted rudiments.

STURIONES, the family of cartilaginous fishes comprising the Sturgeons.

SUB-CAUDAL, a term descriptive of the situation of the pouch of the Pipe-fishes, which is at the lower part of the body and near to the tail. It is of course applicable to any other object similarly situated.

SUCTORIAL, sucking. Lat. *suctus*. The word is applied to those tribes of insects that obtain their food by suction.

SUPERINCUMBENT, Lat. *super*, above, *incumbens*, lying or leaning upon: a geological term used in describing the position of stratified rocks.

TECTIBRANCHIA'TA, an order of mollusks, in which the gills are concealed under the fold of a mantle, as in the Aplysia or Sea-hare. Lat. *tectus*, covered or protected, and *branchiæ*, gills.

TENTACULA, retractile organs surrounding the mouth, and used by many aquatic animals for seizing their prey.

TERRESTRIAL, connected with or relating to the earth. Lat. *terra*, the earth.

TERTIARIES, the feathers in the wings of birds which grow on the *humerus*, or bone corresponding to that between the elbow and the shoulder.

TERTIARY ROCKS, "a series of sedimentary rocks with characters which distinguish them from two other great series of strata—the secondary and the primary—which lie *beneath* them."—LYELL.

TESSELATED, divided into squares. The term is applied to a pavement formed of square-shaped stones, often of different colours. Lat. *tessera*, a square tile.

TESTACEA, mollusks with a shelly covering, such as the Snail, the Whelk, the Oyster. Lat. *testa*, a shell.

TESTUDINA'TA, that order of Reptiles which includes the Tortoises. Lat. *testudo*, a tortoise.

THORAX, the chest. In the true insects, the organs of locomotion, whether wings or legs, are attached to the *thorax*.

THYSA'NOURA, an order of *apterous* or wingless insects, which have the tail fringed with numerous minute hairs. Gr. *thysanoi*, fringes, and *oura*, the tail.

TORPIDITY, that state of rest observable in the hybernating animals, in which they remain without exerting any of the powers of active life, and with diminished animal heat and respiration. In many cases the word implies benumbed with cold.

TRACHE'A, the wind-pipe.

TRANSFORMATION, the changes which animals undergo in their progress from the ovum or egg state, until they assume the appearance of the perfect animal.

TRANSITORY, continuing but a short time.

TRANSLUCENT, permitting the light to pass through. Lat. *translucere*.

TRANSVERSE, across, being in a cross direction. Lat. *transversus*, from *transvertere*, to turn across.

TRILO'BITES, a tribe of extinct crustaceous animals, so called from the body being composed of three lobes.

TRIPOLI, a powder used for polishing metals and stones, first imported from Tripoli. It is composed in a great degree of the flinty cases of Infusoria.

TRIPOD, with three feet, or resting on some support of an analogous kind. Gr. *treis*, three, and *pous*, a foot.

TRIRADIATE, arranged in the manner of three radii, or lines proceeding from the same centre.

TUBERCLES, small pimples, or similar excrescences, giving a rough or warty appearance to the surface.

TUBULIBRANCHIA'TA, an order of mollusks, to which the Vermetus belongs. The gills in some of the species are arranged in a somewhat tubular form, and follow all the windings of the convoluted shell.

TUNICA'TA, a class of molluscous animals, having a leathery or a membranous covering, instead of one formed of shelly matter. In many other respects their structure is very remarkable and peculiar. Lat. *tunica*, a tunic.

TYPICAL, that which is regarded as the type or representative of a particular group.

UNDULATION, a movement in curved or arching lines resembling that of a wave. Lat. *undulatus*, from *unda*, a wave.

UNIQUE, singular, single, one only. French, *unique*.

UNIVALVE, a term applied to a shell which, like that of the whelk or the limpet, consists of only one piece.

VACUUM, a space unoccupied by matter—most usually employed to denote a space from which the air has been exhausted.

VENTRAL, belonging to the belly. Lat. *venter, ventris*, the belly.

VENTRICLE, a term applied to one or to two of the cavities in the heart of the vertebrate animals.

VERMIFORM, worm-shaped. Lat. *vermis*, a worm.

VERMIGRADE, moving like a worm. Lat. *vermis*, a worm, and *gradior*, I advance.

VERTEBRAL COLUMN.—"Vertebral, as consisting of segments of the skeleton which turn one upon the other, and as being the centre on which the whole body can bend and rotate; from the Latin, *verto, vertere*, to turn."—OWEN.

VESICLE, a small enclosed space like a little bladder. Lat. *vesicula*.

VIBRATILE, possessing the power to vibrate. Lat. *vibrare*, to shake.

VITALISED, with the power of sustaining life. The term is applied to water containing atmospheric air, and which is thereby fitted for the respiration of aquatic animals. Lat. *vita*, life.

VIVIFIED, endued with life. Lat. *vivere*, to live—*vivificare*, to cause or give life.

VIVI'PAROUS, producing the young alive. The word is used in opposition to *oviparous*, already mentioned.

WEALDEN FORMATION, a geological term applied to a fresh-water deposit in the South of England. It belongs to the upper part of the secondary series of rocks, and attests the former existence in that region of a large river.

ZOOLOGY, that department of science that treats of the structure, habits, and classification of animals. Gr. *zoon*, an animal, and *logos*, a discourse.

ZOOLOGIST, one who has acquired a knowledge of Zoology.

ZOOPHYTES, a class of radiated animals, formerly supposed to partake of the nature of both animals and plants. Gr. *zoon* an animal, and *phyton*, a plant.

THE END.

QUESTIONS

ON

PATTERSON'S ZOOLOGY FOR SCHOOLS.

PART I.—INVERTEBRATE ANIMALS.

INTRODUCTION.—P. 1.

What is the meaning of the word "Zoology?" What is the first thing to be done in attempting a classification of animals? The bat flies in the air; why is it not classed with birds? The whale swims in the sea; why is it not a fish? What must form the basis of classification? What is the object of it? What division was proposed by Lamarck? What was taught by Cuvier? Into how many principal groups did he divide the animal kingdom? What are the names of those groups?

RADIATA.—P. 3.

To what kind of animals is the term applied? What is the arrangement of their nervous system? Into how many classes are they divided?

CLASS I. INFUSORIA.—P. 4.

To what creatures is the term applied? What is the origin of the term? What is their size compared with that of the globules of our blood? What is Ehrenberg's calculation? Where are they found? Into what *orders* are they divided? Explain the meaning of these two terms.

POLYGASTRICA.—How did Ehrenberg find they had a number of stomachs? How do they move? What is the meaning of *cilia?*

ROTIFERA.—What is their structure? How do they feed? What experiments were made by Fontana? What modes of reproduction have been observed among the *infusoria?* How do they conduce to the purity of the atmosphere? What is said of their silicious shells? How many were calculated to be in a cubic inch of *tripoli?* What effects are now occurring from similar deposits?

NOTE.—The organisms by which those silicious shells are deposited, having been more minutely examined, are of late regarded as more properly belonging to the vegetable than to the animal kingdom.

Class II. Entozoa.—P. 11.

What is the meaning of the term? How many species infest the human body? In what situations are they found? What is the mode of reproduction in the tape-worm? What is the estimated number of *ova* in another species?

Class III. Zoophyta.—P. 14.

What is the meaning of the term? Who was the discoverer of the true nature of these creatures? When did this occur? Wherein is the radiated structure shown? Meaning of *tentacula*? Of *polypi*?

Order I. Hydroida.—P. 15.—Whence the name? Describe the Hydra. What power is possessed by the *tentacula*? How are the young produced? By whom was the Hydra made known? When did he live? What did he say of its vitality? What other particulars does he recount? What is the name of the next family of Zoophytes? Describe the *Tubularia*. What is said of their reproduction? How do the young use their *tentacula*? Name the next family. Meaning of the term? How are the polypes connected with the stem? What does the repetition of any organ indicate? Give examples of this in other orders. Where are the germs produced? How are they diffused? How developed? What number of polypes may be found on a single plume? What number on a polypidom? What is said of their transitory existence? Do they possess any luminous property? When is it exhibited?

Order II. Asteroida.—P. 20.—Meaning of the term? Where do those animals live? What is the *Virgularia*? Where found? What is the *Gorgonia*? How is it flexible? What difference of structure is seen in the *Isis*? What is said of the red coral?

Order III. Helianthoida.—P. 22.—Meaning of the term? What is the aspect of the Sea-anemone? Where found on our coast? Meaning of *Actinia*? On what does it feed? How long was one kept alive by Sir J. Dalyell? To what use has a French philosopher proposed their being applied? What is said of their power of bearing mutilation? What anecdote is told by Dr. Johnston? To what order do the coral-building polypes belong? What is the extent of some of the coral reefs? How are they preserved and increased? What is Darwin's theory of their formation?

Order IV. Ascidioida.—P. 27.—What is the origin of the term? Where are such polypes found? What is their distinguishing peculiarity of structure? To what Zoophytes is the term "flustra" applied? What is Dr. Grant's calculation? To what higher organised animals do they bear the closest affinity?

Class IV. Radiaria.—P. 29.

How are these animals distinguished from any previously treated of? Into what groups are they divided? What situations do they respectively occupy? What is the integument of each?

ORDER I. ACALEPHÆ.—P. 30.—Meaning of the term? What is said by Owen? What of their structure? Their distribution? Peculiarity of *Diphya*? Of *Physalia*? Of *Velella*? Where taken? Size and form of *Cydippa*? Meaning of *Ciliogrades*? Of Beröe? Their movements? *Tentacula* and their uses? Their food? Their vitality? What is said of a different species? How many species of Medusæ or jelly-fishes? What differences do they exhibit? How do they move? How do they breathe? Meaning of *Pulmonigrades*? Size? Colours? Structure of *Rhizostoma*? Of *Cyanea*? Ovaries of *Cyanea*? Growth of the young? Describe its changes. Give proof of the small quantity of solid matter in a *Cydippe*. In a *Medusa*. Phosphorescence of *Acalephæ*. Luminosity of the sea—to what owing? Cause of colour in the Greenland Sea? Scoresby's calculation of their numbers? State the concluding observations.

ORDER II. ECHINODERMATA.—P. 42.—Meaning of the term? Where do animals of this class live? How are the young produced? By what means are they diffused? What changes do they undergo? What is said of the *Cribella*? What of the similarity or dissimilarity in the appearance of the animals of this group? Into how many families are they divided?

First Family.—Meaning of *Crinoideæ*? Their English appellation? Were they more or less abundant formerly than now? What English names have been given to the detached vertebræ? What opinion prevailed prior to 1823 respecting these animals? What was announced in 1826? By whom? What observations were made in 1840? How many arms has this species? What is its colour? What tinge does it impart to fresh water?

Second Family.—Meaning of *Ophiuridæ*? English appellation, and why given? What is their size? What is said of a species of *Ophiura*?

Third Family.—Derivation of *Asteriadæ*? Describe the "Five-fingers." Explain the use and mode of employing the suckers. What occurs if an arm be broken off? What opinion do oyster-fishermen hold respecting it? How does it appear to overpower the oysters? What specific name has been applied to a species of Luidia? Explain why this name is appropriate.

Fourth Family.—What is meant by *Echinidæ*? What is the general form of these animals? How do they move? How is the "shell" or covering enlarged? How many suckers have been estimated in a sea-urchin of moderate size? How many spines? How is respiration effected? What took place when one was cut in two? What is meant by the "lanthorn of Aristotle"? What does Professor Jones say of these jaws? Describe the appearance of a boring species.

Fifth Family.—The scientific name? The English name? How do they move? What is said of their power of reproducing lost parts? To what use have they been applied? What English name was given to a Cornwall species?

Sixth Family.—What do these animals resemble? Where are they found? What does Professor Forbes remark of the British species of this order?

ARTICULATA.—P. 57.

What are the characteristics of this division as distinguished from the preceding? Into how many classes are the articulated animals divided? State the name of each class, and give examples of the animals comprised in it.

Class I. Annellata.—P. 59.

What is the meaning of the term? By what peculiarity of structure are leeches distinguished? How do they move? How do they breathe? Is the medicinal leech a native of Ireland? Is it of England? From what countries is the supply derived? How can the leech draw blood? How is it stored up? In what sense was the word "leech" formerly used? How is the winter passed by the horse-leech? Give an instance of this. In what respects does the body of the earth-worm differ from that of the leech? How does the earth-worm move? When do they go abroad? How are they produced? What is the colour of their blood? On what do they feed? What are their uses? What is stated by Mr. Darwin? What is said by Dr. Carpenter as to the body being cut in two? What experiments were made by a French naturalist? What peculiarity of reproduction is observed in the *Nais*? How is respiration carried on in the "lob-worm?" How in the *Terebella*? How in the *Serpula*? What are the *Errantes*? What are their dimensions? What is the covering of the "sea-mouse?" What are its colours? Name the four tribes of Annelids now enumerated. Where is the hair-worm found? What is its length? What error respecting it is still current? Give examples of the different meanings in which the word "worm" has been used. Are any of these animals luminous? Where have they been observed? Does any species inhabit rock-pools? How is its presence manifested?

Class II. Cirripeda.—P. 68.

What tradition is told of the Barnacles? What scientific name commemorates the error? What are the metamorphoses of the Lepas? What of the Balanus? How were the shells of these animals formerly classed? What simple experiment is mentioned?

Class III. Crustacea.—P. 72.

What is the meaning of the term? What are the uses of a hard covering to animals of this class? Of what material is it composed? Where do the Crustacea live? What is said of their form? What are the characteristics of the class? How is the size of integuments made to keep pace with the growth of the animal? What is said of their power of reproducing an injured limb? How is respiration carried on in the common crab? How in the *Phyllopoda*, or "gill-footed?" How in the *Oniscus*? How in the land-crabs? Why are land-crabs drowned by long immersion in water? What is meant by "pedunculated" eyes? What by "sessile?" What is the structure of the eye in *Daphnia*? What is it as shown in a fossil species (*Asaphus?*) What are

Trilobites? What inferences have been deduced from the structure of their eyes? Are *Crustacea* born alive or produced from ova? Do they undergo any metamorphoses? What was the former opinion on this point? By whom was the true statement first brought forward? What were his observations? To what animal had the term *Zoea* been applied? Are any land-crabs found in Europe? What does Col. Sykes say of some Indian species? What is said by Bishop Heber? What line of march is pursued by those of the Antilles? For what purpose is this undertaken? How are Crustacea classified? Why are "spider-crabs" so called? What observation was made on one of them by Mr. Thompson? How is the large edible crab captured? What weight does it attain? Is the smaller species used as food? To what use are they applied by fishermen? What are pea-crabs? Where found? In what numbers? Why are hermit-crabs so called? For what purpose is a shell necessary? How is it selected? What is the structure of the tail of the lobster? How are lobsters captured? What dimensions are attained by the spiny lobster? What is said to be the longevity of the cray-fish? How are the young supplied with food? In the event of capture, how do the parents act? What appearance is presented by the cast-off shell? What is said by Mr. Ball on this subject? Is the shrimp common on all parts of the coast? Is the prawn? In what situations are the smaller Crustacea found? Why is the *Cyclops* so called? What does Jurine say of its fecundity? What of its cannibalism? What is the appearance of the *Daphne?* How are its ova protected during winter? What are the habits of the *Limnoria?* Do any of these animals possess luminous powers? What are the *Epizoa?* What is said of their numbers? State the remarks of Mr. J. V. Thompson.

Class IV. Insecta.—P. 92.

What is the origin of the term? Into how many parts is the body divided? What is the structure of the heart? What is said of its pulsations, and of the circulating fluid? How is respiration effected? What is the structure of the *trachcæ?* What are the *antennæ?* What are their supposed functions? Have insects the sense of smell? What instance is given by Mr. Knapp? Have they that of hearing? Give an example. Are the eyes sessile or otherwise? What is the most usual number? How many eyes has the whirl-gig? What is the most common kind of eyes? How many lenses have been computed in the eye of a dragon-fly? Of a gad-fly? An ant? A house-fly? A butter fly? and in that of a species of beetle? For what apparent object are they bestowed in such abundance? What is meant by the "metamorphoses" of insects? Mention their different states, and the terms used to denote them. What is the nature of the food of insects? Name the several parts of the mouth. Are those parts invariably present? What is the number of the wings? What are the *elytra?* What does Professor Owen say of the wings? On what is the classification of insects founded? Give the note enumerating the several orders, and examples of them.

ORDER I. COLEOPTERA.—P. 107.—Meaning of the term? What is said as to the size of these insects? Why is the death-watch so called? What does its note resemble? What differences are observable in the male and female glow-worm? Why is the "blind beetle" so called? How does it feign death? What was the sacred beetle of the Egyptians? Why does it roll balls of dung? What are the habits of the cicindela? Of the cock-chafer? Of the nut-weevil? Of the burying beetles? How many species of coleoptera are now known?

ORDER II. ORTHOPTERA.—P. 112.—Meaning of the term? What insects belong to it? What are the habits of the mantis? The house-cricket? What is said of its song? What of the note of the field-cricket? Habits of the cockroaches? Of the locusts? How many species of locusts have been captured in Britain?

ORDER III. NEUROPTERA.—P. 116.—Meaning of the term? What insects belong to it? What are the characteristics of the order? Where do dragon-flies pass their *larva* state? What is the French term for them? Where are the eggs of the May-flies deposited? What is the covering of the *larvæ*? What is the ephemera?

ORDER IV. HYMENOPTERA.—P. 119.—Meaning of the term? Number and structure of the wings? State the other characteristics. What insects belong to it? Why are the saw-flies so called? Mention a well-known species? What are gall-flies? In what numbers are they found? What is the true nature of the Dead Sea apples? What are the *Ichneumonidæ*? How many species are known? What are their habits? What hypothesis prevailed formerly about them? How many have been known to issue from one chrysalis? Why are the wingless ants we usually see included in this order? What is said of males, females, and neuters? What is honey-dew? In what state do ants pass the winter in these countries? What is the common belief? How has this been confirmed? What is said by Solomon? What does Col. Sykes say of an Indian species? Wasps—of what does their community consist? What is said of their habits? Of what material is their nests composed? In what way do the sand-wasps provide for their young? Into how many groups may bees be divided according to their habits? In what places do the solitary species make their nests? Describe the habits of the *Zylocopa*. Do the same with the mason bees; also with the leaf-cutter bees. Is there any one circumstance which distinguishes the social bees from the solitary? Of what kinds is the community composed? What are the habits of the humble-bees? To what blind man are we indebted for much of our information respecting the hive-bee? What are the duties of the workers? What is done to the males in autumn? What are the habits of the queen? How is the want caused by the death of the queen supplied? How is honey collected? How is pollen carried to the hive? How is wax produced? What is said of the form of the cells? What place in Greece was celebrated for its honey?

ORDER V. STREPSEPTERA.—P. 132.—What is said of the size of these insects? What of their length of life? Where do they pass the earlier stages of their existence?

ORDER VI. LEPIDOPTERA.—P. 133.—What are the number and

structure of the wings? What moth might seem to have a greater number? What is the structure of the mouth? How is food obtained? What is the number of these insects? What are their colours? Into what groups are they divided? Are certain butterflies limited to certain localities? What are the hawk-moths? What other name is applied to them? Name the largest European species. What are its dimensions? Its habits? Why regarded with terror? How has the word "moth" been used? What size do some attain? What proof can be given of the minuteness of some caterpillars? Why are some called "surveyors?" What is said of the habits of the leaf-rollers and others? From what source is the supply of silk procured? What is said of its value in ancient Rome? What of its abundance in China? At what time were the eggs brought to Constantinople? Under what monarch introduced into his dominions?

Order VII. Hemiptera.—P. 139.—Is the mouth formed for suction or mastication? What are the number and structure of the wings? What insect of this order was in great repute at Athens? How is the cuckoo-spit produced? On what do the *Aphides* subsist? What is the most remarkable circumstance in their production? To what family do the scale-insects belong? What is the appearance of the female? What is cochineal? Where is it procured? How many insects may be in a pound weight? What other insects are mentioned as belonging to this order?

Order VIII. Diptera.—P. 143.—How many wings have the insects of this order? What is the mouth adapted for? How many species are known as natives of Ireland? How many European species of the family *Muscidæ*? What is the use of the flesh-flies? What is said of their powers of increase? What of annoyance from the house-flies? Of sufferings from musquitoes? Of irritation from the gad-flies? Of terror caused by bot-flies? What families are noted for their aërial dances? What is said of alarm occasioned by these flies? What phenomenon was observed in 1842? Why do they thus congregate?

Order IX. Aptera.—P. 148.—Into how many orders is the Linnæan order *Aptera* now divided? Give the scientific name of each order and its meaning. Give examples of the insects belonging to each.

Class V. Arachnida.—P. 150.

What animals are included in the present class? What are their characteristic peculiarities? How many pair of legs have they? What is said of the eyes? What of the senses of hearing and smell in the spiders? How is the poison of the spider conveyed? Where is it lodged in the scorpion? What is said of the compound structure of the spider's thread? What of the two kinds of thread composing the net of the garden spider? To what use is one of these applied by the astronomer? Is the spider cruel? What is gossamer? What different modes of life are observable among spiders? What of their habitations? What of the affection of the female for her young?

MOLLUSCA.—P. 155.

What is the meaning of the term? What is the arrangement of the nervous system? What is remarked of the blood? Where are they found? What is said of their form and colouring? What of the uses to which they are applied? What of their sizes? How is the shell secreted? Of what is it composed? How is the colouring matter deposited? Give examples of change of form in shells with their growth, or from other circumstances. What was done by Aristotle in this department of knowledge? What by Pliny? What by Linnæus? What by Cuvier? What are the two leading divisions of the Mollusca? Into how many "classes" are each of these groups divided? By what characteristics are these classes distinguished? Give the name of each, and the meaning of the term.

Class I. Tunicata.—P. 163.

What kind of mollusks are said to be "tunicated?" What is best known species? Describe its appearance and structure. Has any species a transparent covering? What has been observed respecting the circulation in these animals? Are the young free or fixed? Do any of them possess a power of budding? What are *Botrylli?* What is the most striking peculiarity of the *Pyrosoma?* What is stated respecting the *Salpæ?*

Class II. Brachiopoda.—P. 165.

What are they? Where are they found? At what depths? What is Professor Owen's remark?

Class III. Lamellibranchiata.—P. 166.

What is the structure of the gills? What common mollusks belong to this class? Where do the ova remain for some time? What is said of the young? How is the oyster supplied with food? Are they sensible of changes of light? Where are the young deposited? What of their growth? State the origin of pearls. What has been said of the value of some? Where is the pearl oyster found? How long can a diver remain under water? What revenue was at one time derivable from the pearl fisheries of Ceylon? How does the large scallop move? What is meant by the "byssus" of the mussel? What use was made of it at Bideford? To what has that of the Pinna been applied? Describe the use of the foot of the cockle? What is its structure? What was believed to be the weight of limpets used as food at Larne in 1837? What was the entire weight of "shell-fish" as carried from the beach? What prices are Carrickfergus oysters compared with pearl oysters? Give examples of certain species used as food, being restricted to certain localities. Mention some of the boring mollusks. State instances of damage done by the Teredo. What is the best defence against them? What example is given of benefits derived through their agency?

Class IV. Pteropoda.—P. 175.

How are the mollusks of this class distinguished? What species is abundant in the Arctic seas? Describe its appendages and suckers.

Class V. Gasteropoda.—P. 176.

What is the structural peculiarity of this class? How is it divided into orders? Name the first of these, and explain the meaning of the term. Name the next, and explain it also. The same with each of the others. What are the habits of the *Nudibranchiata?* To what order does the limpet belong? How is its food procured? What is the peculiarity of the *Chiton?* To what order does the sea-hare belong? What is said of one when captured? What tradition was current about it? To what order do slugs belong? Do they possess great sensitiveness? Any reproductive power? What safeguard to some extent is enjoyed by the young? Have any of these animals a rudimental shell? How many species of *Helix* are found in Ireland? What is said of them as food for birds? Are any species eaten by other animals? Have any been eaten by man? To what order does the common whelk belong? For what is the dog-whelk remarkable? What was the Tyrian purple? How was it procured?

Class VI. Cephalopoda.—P. 184.

What are the characteristics of the class? In what points of structure is it superior to the preceding? Where was the pearly nautilus taken? What is said of the structure and the number of its gills? What were the *Ammonites?* The *Orthoceratites?* What cuttle-fishes have two gills? What was the *Belemnite?* What were its habits? What opinions were current regarding the argonaut? What is the true account of its power of moving? What function is performed by the arms with the membranous disc? What is the Poulpe? What is the structure of its arms? Give an example of its powers of attack and escape. In what respect has it an analogy to the chameleon? To what use has the ink of the cuttle-fish been applied? How has the internal bone been used? Has the flesh been regarded as nutritious or otherwise? Where has it been sold? How has the common *Loligo* been used at Newfoundland? What proof is there of its abundance on that coast? What does Mr. Bennett say of the numbers of another species? What exaggerations have been current as to the size attained by some of these animals? What was the actual size of a very large one found by Captain Cook? In what are the ova contained? Are these ova uniformly in clusters or detached? What remark has Dr. Buckland made respecting fossil species? What is said of the importance of shells in a geological point of view? What observations have been made on the microscopic structure of shells? What was discovered regarding their distribution as to depth in the Ægean Sea? What as to their geographical distribution? What is the inference to be drawn from these phenomena?

PART II.—VERTEBRATE ANIMALS.

What are some of the most obvious points of difference between the Vertebrate and the Invertebrate Animals? What are the anatomical characteristics of this division? What is bone composed of? Is it uniform in its structure in different tribes of animals? Give examples of this. Name the classes into which Vertebrate Animals are divided. Which of these are cold and which are warm-blooded?

Class I. Pisces.—P. 213.

Give definition of fishes. How is the body covered? How is respiration carried on? How are the young produced? Where are fishes found? At what temperatures can they live? What is said of their forms? What of the Globe-fish? How is the slime on the body of fishes emitted? What is its use? How is the metallic lustre of the scales produced? What covering different from that of scales has been observed? What are the *cirri* of fishes? To what are they analogous? What is said of the sense of taste? Of smell? Of hearing? How does the air-bladder assist this sense? What are the *otolites?* What is said of the sense of sight? What of the blind fishes of the Mammoth Cave? Have fishes eyelids? What is the specific gravity of the body compared with that of water? How is it increased or diminished? What other uses does the air-bladder serve? Is it found in all fishes? What are the external organs of motion? How does the tail act? How are the fins named? What is said of the movements of a Pipe-fish? Does the Flying-fish really fly? How many cavities are in the heart of a fish? How does it breathe? Why does a fish die when kept out of water? What constitutes the food of fishes? How is beneficence shown in the arrangement by which fishes prey on fishes? Give example of the voracity of the Frog-fish. Contrast the teeth of fishes with the organs for prehension in the lower animals. What is said of their size, shape, and numbers? Of their being renewed? What is the use of teeth in the *pharynx?* Are any fish produced alive? What is the general rule? Why are ponds in India which have been dried up found after the rainy season to contain fishes? By what laws are fishes limited in their range? What number of *ova* do some produce? What statement, made by Aristotle, has been confirmed? What is said of the *Hassar?* What of a Stickleback? What mode of concealment is possessed by some flat-fishes? What mode of escape has the Flying-fish? What weapon of defence is used by the Skate? What by the Weever? What by the Spined Dog-fish? What contrivance regarding those spines is described by Mr. Ball? What weapon is used by the common Stickleback? By the Saw-fish? By the Sword-fish? Give example of the force with which this has been used. What defence is employed by the Silurus of the Nile? The Torpedo? The Electric Eel? What is said of the comparative vitality of fishes? Give examples of this. How are Carp fed in Holland? Regarding errors and traditions, state what is said of the Mackerel Midge. What of the origin of Eels? Of the ear-bones of the Maigre? Of the Opah? Of

the John Dory? Of the Remora? On what principle is Cuvier's classification of fishes founded? Into what two great groups are they divided? Name the first Order of osseous fishes and give examples. Name the second group and the Orders into which it is divided. Name the remaining Orders; explain the meaning of the name; give an example belonging to each. Name the three Orders of cartilaginous fishes, give an example belonging to each, and state the difference in the gills and gill apertures.

CARTILAGINOUS FISHES.—P. 239.

Petromyzidæ.—P. 239.—The family of the Lampreys.—What is the origin of the scientific term? What small fish of rare occurrence belongs to this family? How was it formerly classed? What is remarkable in its skeleton? What in the habits of some exhibited at Southampton?

Squalidæ Raiidæ.—P. 240.—In the Sharks and Rays what is the structure of the gills? How are the *ova* deposited? By what names are the empty egg-cases known? How are the young nourished? Among the Sharks, which are larger, the males or the females? Give some of their English names. What is the skin used for? What is said of the small Spotted Dog-fish? Of the White or the Blue Shark? Size of the Basking Shark? What is said of the Blue Shark? As examples of providential care, state the arrangement for aëration of the blood in the young. Also that regarding the teeth of the Sharks.

Sturionidæ.—P. 243.—Family of the Sturgeons.—What is remarkable with regard to the surface of the body? What in the appearance of the tail, as contrasted with that of the Perch? Did this form occur in former ages? Why a royal fish? What dimensions? What is made from it?

OSSEOUS FISHES WITH FLEXIBLE RAYS.—P. 244.

ORDER PLECTOGNATHI.—The Globe-fish and Trunk-fish already mentioned belong to it.

ORDER LOPHOBRANCHII.—How are the gills arranged? What fishes belong to it? Has any fish a marsupial pouch? What is its use?

ORDER MALACOPTERYGII APODES.—Family *Anguillidæ*, that of the Eels. Meaning of the term *Apodes?* What are Sand Eels? What size does the Conger Eel attain? What error is yet current respecting it? How many British species of fresh-water Eels? What is said of the fishery at Toome? What of the young Eels ascending the river Bann? Do Eels ever voluntarily leave the water? What is said of their power of enduring cold?

ORDER MAL SUB-BRACHIALES.—P. 247.—Family *Cyclopteridæ*.—What is said of the ventral fins of the Lump-sucker? Of its power of adhesion? What is said of the value of Turbot brought to the London market? What fishes belong to the family *Gadidæ?*

ORDER MAL ABDOMINALES.—Family *Clupeidæ*, that of the Herring.—What of the White-bait? Importance of the Pilchard fishery? Of the Herring fishery? What does Pennant say of the approach of the Herring? What is the true explanation of the phenomenon? Family *Salmonidæ*.—P. 252.—What is said of the Pollan? Gillaroo Trout, for what remarkable? Size of the Great Lake Trout? Difference of colour, how caused? Mi-

gration? Falls of Kilmorac, salmon how taken at? Quantities taken near Coleraine? How packed? When do the young go to the sea? What is the Parr? Do they return to their native river? *Esocidæ*.—P. 255.—The family of the Pike.—Instances of its rapacity? Its former value? Its longevity? Weight of some native specimens? *Cyprinidæ*.—P. 256.—Family of the Carp.—What of the Gold-fishes? The Carp as mentioned in 1496? The Bream as mentioned by Chaucer? What use is made of the scales of this family of fishes?

Osseous Fishes with Spiny Rays.—P 257.

Order Acanthopterygii.—Characteristics of the Order? Family *Labridæ*.—P. 257.—That of the Wrasse.—Colours of the fish? Local names. *Mugilidæ*.—P. 257.—That of the Mullet.—What is said of the distribution on our coasts of the thick-lipped Grey Mullet? Quantity taken? Weight of a single fish? Nature of its food? Habit of springing over the net? What was the weight of a Red Band-fish sent by post? What was its length? What is said of a Riband-fish found on the coast of Antrim in 1836? *Scomberidæ*.—P. 259.—That of the Mackerel.—P. 259.—The Pilot-fish, why so called? Size of the Tunny? Temperature of its blood? What is said of the Mackerel fishery in 1821? *Sparidæ*.—P. 260.—The family of the Gilt-head. For what are the Sea Breams remarkable? For what the Stickleback and Gurnard? What fish is called the Piper? What is said of a Mediterranean fish? *Percidæ*.—261.—The family of the Perch.—What prices were given by the Romans for some of the true Mullets? What is told of the habits of the Perch? What opinions have prevailed as to the place of the *Lepidosiren*? Where is it found? What are its habits? What arrangement has been proposed by Agassiz for fossil fishes? What conclusion is arrived at by a comparison of fossil fishes with those now living?

Class II. Reptilia.—P. 265.

What are the characteristics of the Class? Where are reptiles most numerous? What is the number of living species? How were they divided by Cuvier? How many species belong to each Order? How many are inhabitants of Italy? Of France? Of Britain? Of Ireland? Why is the blood cold?

Order I. Amphibia.—P. 267.—How is the Order divided? What strange animals belong to the first group? Describe the metamorphoses of the Frog. On what does it feed? How is the food captured? What are Tree-frogs? How is respiration effected? Is the Frog considered as formerly indigenous in Ireland or as introduced? Is any species of Toad found in Ireland? What does popular tradition in Ireland say of the "Mankeeper"? What in England of the Toad? What evidence is there of the existence in former times of gigantic *Batrachian* reptiles?

Order II. Ophidia.—P. 274.—How many joints are in the spinal column of the Rattlesnake? In that of the Viper? In what climates are they most numerous? What is said of them in reference to islands in the Pacific Ocean? What as regards America? What are their habits? What are the comparative numbers of the poisonous and the harmless tribes? How does

the Boa-constrictor kill its prey? Describe the structure of the jaw. Same of the poison-fangs. What is said of the poison? Of the Rattlesnake? Of the Naja or Asp? Of the Cobra-di-capello? Of the Python? What evidence of the former existence of large serpents in England? What species now represent there the poisonous and the harmless tribes? What of the bite of the Common Viper? How do the English snakes pass the winter? How many were in one instance found together? How is the skin changed? How are the young produced? What are the movements of the Common Snake? What use was formerly made of the flesh of serpents? Why is the Blind-worm so called? What is the cause of the appellation *fragilis?* What peculiar interest attaches to this creature? At what altitude are snakes found?

Order III. Sauria.—P. 281.—What are the characteristics of the Order? How many species are known? Are any used as food? State the habits of some South American species. Where are Iguanas found? What is remarkable in their appearance? What is their food? What is peculiar in the structure and habits of the Geckos? State some of the peculiarities of the Chameleon. Explain its changes of colour. How are the *Lacertidæ* distinguished? What English species belong to this family? How are the young of these two species produced? Give an instance of the tail separating easily from the body. Where are the Caymans found? Where the true Crocodiles? Where the Gavials? In what respect are these reptiles beneficial to man? What was formerly supposed respecting the tongue of the Crocodile? State other erroneous ideas regarding these reptiles. What does Swainson say of the courage of the Crocodile? What provision exists for keeping up the supply of teeth? State how many teeth exist at one time. What was the *Icthyosaurus?* Its size? Its food? How many species? What was the structure of the *Plesiosaurus?* What were its habits? What was its most remarkable characteristic? What was the *Pterodactyle?* How many species are known? What were the sizes? What the peculiarities of structure? What the food? The habits?

Order IV. Testudinata.—P. 289.—What are the characteristics of the Order? Where are the *vertebræ?* How many species are known? How many of these are Land Tortoises? How many fresh-water? How many marine? Where are Tortoises found? Are any included in the British *fauna?* What use is made of the Green Turtle? What article is supplied by the Hawk's-bill Turtle? What is said of its structure and habits? Where are the eggs deposited? What are the habits of the River Tortoises? What of the Marsh Tortoises? What is the food of the Land Tortoises? What are they remarkable for? What is said of the size of those in the Galapagos Islands? What of their habits? What does Pliny say of the size of some in the Indian Sea? What are the ascertained dimensions of a fossil species from India? Did Tortoises formerly live in our own seas? What does Professor Forbes say of Tortoises in Lycia?

Class III. Aves.—P. 297.

What are the characteristics of the present Class? What is

said of the power of flight? What is said of the *vertebræ* of the neck? What of those of the back? What of the breast-bone? What of the "merry-thought?" By what mode is lightness in the bones combined with strength? What is said of the temperature of their bodies? What is remarkable in their respiration? What variety do the feathers exhibit? How do they conduce to warmth? How are those of the wing named? Give examples of long-sustained powers of flight. What tradition was current respecting Birds of Paradise? What is said of the haunts of the Gannet? What of its number? Of its mode of capturing its food? To what depths can they descend in the water? What structural peculiarities give to it the powers it enjoys? What is meant by moulting? Explain the changes in the appearance of the plumage. Of what does the food consist? Mention some of the various uses and forms of the beak. Where is food stored until required? Mention some of the peculiarities of the stomach. What is said of the stomach of the Ostrich? Of the structure of the eyes of birds? How many eyelids have they? Give proofs of their possessing the sense of smell. Give example of the obtuseness of this sense in the Condor? What controversy has prevailed as to their senses of sight and smell? What are the habits of the Adjutant? Enumerate some of the labourers by whom the removal of decaying animal matter is effected. Explain the meaning of the term "migration" as applied to birds. Give examples of the migratory instinct overcoming another powerful one. In what different ways do birds evince their parental affection? Give examples of different kinds of nests. Describe the organs of voice. What bird is remarkable for its powers of imitation? How are birds distributed over different regions? Does Europe possess much variety of species? What are the comparative numbers of species belonging to the different Orders? How many species in all, according to Strickland, are at present known? Into how many *genera* are these divided? Have *genera* a real existence in nature? Have species a real existence? What system of classification is avowedly the best? What is the only sure foundation? In what way are the external parts said to be an index to the internal? What union of knowledge is involved in the idea of a perfect system of classification? Into how many Orders are Birds divided? What reasons are given for commencing in this book with birds of prey, rather than with swimming birds?

Order I. Raptores.—P. 327.—How distinguised? What are the structure and position of the toes? Into what families are they divided?

Family I.—Vulturidæ.—P. 327.—How distinguished from the other families? Are any permanently resident in these countries? What species have been recorded as taken? What are their habits? By what peculiarities is the Condor distinguished? What erroneous ideas were current respecting it? What are its true dimensions? To what elevation does it ascend? Describe the appearance of the Lammergeyer. Where is it found? What is told of its audacity?

Family II.—Falconidæ.—P. 330.—How distinguished? To

what source of error are we liable? What species of Eagle are permanently resident here? To what country does the Spotted Eagle belong? Golden Eagle—its aspect? Power of vision? Capture of food? Its boldness? Popular error? Habits? Situation of eyrie? How destroyed? The true Falcons, how distinguished? Haunts of the Peregrine? This species, how used? Terms applied to it in falconry? How carried? How bedecked? Meaning of "lure," "quarry," &c.? Former value? Rapidity of flight? Boldness? Rapacity of a female? Hawks, how distinguished from true Falcons? How many British species? Size of Gos-hawk? Colour? Character of Sparrow-hawk? The Kite, how distinguished when on wing? Is it rare in Ireland? Honey-buzzard, where native of? Hen-harrier, its prey? Its strength?

Family III.—Strigidæ.—P. 340.—Flight of Owls? Time of appearance? Sight? Superstitious fear of them? Dimensions? Snowy Owls, where native? What species most common in these countries? Their haunts? Food? Habits of a pair of White Owls? Eagle Owl, where native? Give instance of its attachment to its young? Habits of a South American species?

Order II. Insessores.—P. 342.—Meaning of the term? What this Order does *not* include? How many native species? How do birds perch? Into how many tribes are they divided? Give the names and an example of each.

Tribe I.—Dentirostres.—What other birds do the Butcher-birds resemble in habit and form of bill? What is their food? How is it treated by them? Where is the Water Ouzel found? What question has arisen as to its habits? What is said of the song of the Missel Thrush? And of that of the Song Thrush and Blackbird? What birds belong to the family *Sylviadæ?* What is the food of the Robin Redbreast? Its habits? Give examples of its building its nest in strange places. For what is the Nightingale distinguished? Is it resident in England at all seasons? Is it found in Scotland or in Ireland? Are its notes indicative of sorrow? Why are Humming-birds so called? What is said of their size? Of their food?

Tribe II.—Conirostres.—P. 349.—Sky-lark, what peculiarity is there in the foot? On what does it feed? When is it fattest? For what object does it dust itself? What is said of its song? What other birds belong to the same family? For what power is the Starling remarkable? What is said of its migrations? On what do Starlings feed? How are their evolutions described? What fables were current respecting Birds of Paradise? What species belonging to the *Corvidæ* can imitate the human voice? What are the haunts and habits of the Raven? Where have the Hooded Crows been observed? What does Washington Irving say of a Rookery? What is said by MacGillivray? What by Knapp? Do Rooks do more good or more harm to the farmer? On what do they feed? What is Jesse's evidence on the question? What recorded instances are there of their destruction in great numbers? What other species belong to this family? What is told of the Daws at Cambridge? Why are the Horn-bills so called? In what countries are they found? What is their food?

Tribe III.—Scansores.—P. 357.—By what peculiarity of struc-

ture are those birds distinguished? What is the food of the Woodpecker? How is it procured? For what is the Wren remarkable? For what habit, as regards its eggs, is the Cuckoo distinguished? Is the same habit observed in the American species? Mention some of the poets who have referred to the cheerful note of the Cuckoo.

Tribe IV.—Fissirostres.—To what countries do the Bee-eaters belong? Which British bird possesses the most brilliant plumage? What are its habits? What fables were current about the Halcyon? What bird, traduced by popular report, is included in this tribe? What does Sir Humphrey Davy say of the Swallow? About what date does the Swallow arrive in these countries? Where does it build? What is its food? How is it distinguished from other species? How is the House-martin distinguished? By what poet is the situation of its nest referred to? Where else have those nests been observed? Do the House martins return to the nests they formerly occupied? What was done by a pair when they found a swallow in possession? What explanation is suggested by Mr. Thompson? Is the Sand-martin smaller or larger than the House-martin? How soon does it arrive? Why is it called Sand-martin? How is the Swift distinguished from any other species? Where are its nests found? In what month does it arrive? In what does it depart?

Order III. Rasores.—What is the meaning of the term? What domestic bird exhibits the habit? What other birds belong to the Order? Family *Columbidæ*.—P. 363.—What other names are given to the Wood-pigeon? What of the injury these birds are said to do to farm-crops? Where does the Rock-dove build? Of what Doves is this the origin? How is the Carrier-pigeon trained? How many miles has it been known to fly in an hour? At what season does the Turtle-dove visit these countries? Of what country is the Passenger-pigeon a native? How many, according to Audubon's estimate, may be in a single flock? How many bushels of grain would such a flock consume daily? Family *Phasianidæ*.—What country did the Common Pheasant come from? To what country is the Red Grouse restricted? What are its haunts? Where is the Black Grouse found? Where the Ptarmigan? What is the meaning of its generic name *Lagopus?* What is the colour of the plumage in summer? What is it in winter? What well-known species, not yet mentioned, belongs to this family? What interest attaches to the Quail? Where is it found? What are its habits? What bird of large size, once living in these countries, is no longer found here? What countries does it yet inhabit? Family *Struthionidæ*.—Are Bustards plentiful? What is said of the Great Bustard? What of the Little?

Order IV. Grallatores.—P. 367.—Meaning of the term? Do the Ostrich and the Plover exhibit the peculiar characteristics of the Order? What was Cuvier's arrangement? What is remarkable in the structure of the Apteryx? What are its habits? Family *Charadriadæ*.—Origin of the name Plover? Where is the Golden Plover found? How does it appear to have a double moult? For what device are some of these birds remarkable?

What is the origin of the name Lapwing? What name has been suggested by its note? Is the Common Crane a native of these countries? What does Gould say of this bird? What situations are frequented by the Common Heron? What is remarkable about its appearance when at rest? What when on the wing? Where does it build? Is the Common Bittern a common bird? What is said of its "booming?" What was it considered the emblem of? For what is the Stork remarkable? In what country was it in former times regarded with reverence? What other species belonging to this family has been looked on as sacred? Family *Scolopacidæ*.—P. 371.—What birds belong to this family? What is the range of the Woodcock? When does it fly? On what does it feed? Do any breed in these kingdoms? Family *Rallidæ*.—P. 372.—What is the best known species of Rail? What other birds belong to this family? What difference is observable in the foot of the Water-hen and the Coot?

Order V. Natatores.—What are the general characteristics of the Order? In what respect is the Flamingo allied to Order IV. and also to Order V.? What is the meaning of its scientific appellation? Family *Anatidæ*.—P. 374.—What birds belong to this family? What figure does a flock of Wild Geese assume when flying? What are the best known species? What is said of their watchfulness? At what season are the Brent Goose and the Bernicle procured? What name is given to the Brent Goose in Belfast Bay? What is said of the Whistling and of the Mute Swan? Where are Black Swans found? What article is procured from the Eider Duck? Where are its haunts? How is the down collected? Family *Colymbidæ*.—What birds belong to it? What are the habits of the Great Northern Diver? How has it occasionally been captured? Family *Alcidæ*.—What names have been given to the Puffin? What is said of the wings of the Penguin? Give examples of the courage of these birds. Family *Pelecanidæ*.—How many native species belong to this family? What is said of the Common Cormorant? How are Cormorants used by the Chinese? Family *Laridæ*.—What birds belong to this family? What other name has been given to the Terns? How do they take their prey? What is meant by a "play of gulls?" What is their food? How are gulls sometimes captured? What food do they seek in spring? What are they said to destroy at Horn Head? What is said of the Black-headed Gull in Norfolk? What at Lough Neagh? What is said of the Common Gull of Belfast Bay? What name has been given to the Stormy Petrel? What are its habits? What use is made of Petrels in the Hebrides and at St. Kilda? Has the Fulmar been found on the Irish coast? Has the Stormy Petrel? What situation did it occupy at Tory Island? How were Petrels affected by the storm of 1839? What does Darwin say of another species? Contrast the multitudes of different species of birds. What is remarked of their abundance or scarcity in a fossil state? Of what island was the Dodo a native? What was its probable weight? To what tribe did it belong? Are any foot-prints existing of large birds now extinct? What was Professor Owen's opinion of large bones from New Zealand?

To what genus were they all referred? What hypothesis has been suggested by these remains?

CLASS IV. MAMMALIA.—P. 385.

What is the derivation of the term? How many compartments are in the heart? What is said of the circulation as compared with that of birds? How is respiration effected? How are the lungs situated? What is their structure? What is the characteristic covering of the Mammalia? What different aspects does it assume? What is the usual number of feet? What term is from this circumstance often used as synonymous with *Mammalia*? State some of the changes observable in the form or number of the extremities. Is the number of joints or *vertebræ* in the spinal column uniform or not? What is the number in the neck of the Elephant? What in that of the Giraffe? What peculiarity is observable in the head of the Tapir? In that of the Elephant? Of the Rhinoceros? Of the Giraffe? Of the Stag? What name is hence given to animals of the Deer tribe? What was the weight of the antlers in the "Irish Elk"? In what space of time did they grow? What difference of structure is observable in the horns of the Goat and the Ox, compared with those of the Deer? What name has from this circumstance been given to these animals? Are the tusks of the Elephant regarded as part of the dental system? What teeth do they represent? What size and weight do they attain? What evidence is there of the former abundance of Elephants in Siberia? What is whale-bone? What is its situation, and its use to the living animal? How many teeth has man? How are they called? How are they placed? Are they absent in any species of Mammalia? Mention examples of difference in the number. What has been observed with regard to the adaptation of the teeth to the food? What inference is thus suggested? Is there any instance in nature of an incongruous union of parts? Can the comparative anatomist venture to deduce the size, structure, and habits of an extinct animal from a portion of its skeleton? Who led the way in this field of discovery? What organs did he regard as furnishing the surest basis for classification? Into how many Orders are the inferior animals now divided? How is man classed? Name the eleven Orders, and give an example of each? What is the estimated number of species? How many are British? How many are Irish? What causes appear to influence the geographical distribution of animals? What does Lyell say of the Mammalia of North America?

ORDER MARSUPIATA.—P. 397.—What is the derivation of the term? In what particular prior to birth do the young of this group differ from other Mammalia? What animals are included in the Order? Over what parts of the world are their remains distributed? What is their food? What was the size of a young Kangaroo measured by Professor Owen? What use is the pouch of the mother? What diversity is shown in size? What name is given to one section of the Marsupial animals? What does the *Echidna* resemble? What are the peculiarities of the *Ornithoryncus*? What are its habits? What are the habits of the

Kangaroos? What occurred in the Surrey Zoological Gardens? Where are the Opossums found? What is their size? Their food? What is the structure of the feet? Have they pouches like the Kangaroos? If not, how are the young carried without falling?

Order Rodentia.—P. 402.—What common animals may be taken as representing this Order? What definition of Rodents is given by Jenyns? What number of species is known? What proportion does this bear to the entire number of Mammalia? How many species belong to the family of the Squirrels? How many to that of the Rats and Mice? How many to that of the Porcupine? To what continent does that animal essentially belong? Are any species of this Order peculiar to Polynesia? How many British species of Rodentia? How many Irish? What English genus containing three species is unrepresented in Ireland? What is remarkable in the molar teeth? Describe the growth of the incisor? When an opposing incisor is lost, what happens? What is the meaning of *hybernate?* What species do so? Which of them collect a store of food? What apparent usefulness is connected with this Order? What is said of the habits of the Common Squirrel of England? Is it known in Ireland? What is said of the fur of the Scotch and of the English Hare compared with that of the Irish? Is the Irish Hare identical with another formerly believed to form a different species? Where is the Beaver found? Was any species of Beaver ever indigenous to the British islands?

Order Edentata.—P. 408.—Are any of these animals without teeth? What is the true characteristic of the Order? Into what groups is it divided? To what quarter of the world do the Armadillos belong? How are they distributed? What is their food? What is said of their size? How many species of Sloths? What is their food? How have they been spoken of? What does Waterton say of their mode of progression? What must have been the dimensions of the *Megatherium?* What is Professor Owen's opinion as to the food of that animal, and of the Mylodon? How, according to Owen, was the food procured?

Order Ruminantia.—P. 414.—How is this Order distinguished? What is the food? What peculiarity of foot is observable? What is said of defensive weapons growing from the forehead? What animals are included in the Order? Into how many genera are they divided? Into how many species? In what part of the world are they most numerous? What services do they render to Man? Name any countries in which they are not found. What is said of the molar teeth? Into how many groups are they divided by Mr. Waterhouse?

Group I. (*Camelus.*) How is the Camel distributed? Is there any place in Europe where the Arabian Camel is now used?

II. (*Auchenia.*) What is the geographical distribution of the Llamas?

III. (*Moschus.*) Why are the Musk-deer so called? How are they distinguished? What is their habitat?

IV. (*Cervus.*) What are the characteristics of the Deer? What is the largest species now living? What was its size compared with the "Irish Elk?" Why is that name objectionable? With what

fossil remains is its skeleton found? What are the three species of Deer now living in these countries, and in what situations?

V. (*Camelopardalis.*) How many species of Giraffe? To what quarter of the globe do they belong? What is the food, and how procured?

VI. (*Antilope.*) Where is the Chamois found? Where the Gazelle? How many species of Antelope belong to each of the four quarters of the world? What proportion do the Deer and the Antelopes together bear to the other Ruminants?

VII. (*Capra.*) In what localities are the Goats found? Where is the greatest number of species?

VIII. (*Ovis.*) What is the original locality of the Sheep? Where are they now found in a wild state? At what elevation does the Chamois habitually live? At what the Cashmere Goat? The Goat of Thibet? The Pamir Sheep or Rass?

IX. (*Bos.*) What domestic animals represent this group? What foreign species are the most celebrated? How many species did the Romans describe as inhabiting the continent of Europe? Are animals belonging to one of these species yet living? If so, where? What is Cæsar's description of the other? Where have the remains of both species been found?

Order Pachydermata.—P. 421.—Meaning of the term? What are their habits as regards food? Into how many genera is the Order divided? Into how many species? To what zones do they principally belong? Name one great division of the earth's surface where they are not found. Are the Indian and African elephants alike or different? To what continent does the Hippopotamus belong? How many species of Rhinoceros? What European species is the representative of the Swine? Where are the Wart Hogs found? Where the Peccaries? Where the Tapirs? Where the Horse? What is said of fossil remains of these animals? Where are Wild Asses found? Where the Zebras? Of what does the food of the Elephant consist? What three substances enter into the composition of the teeth? Describe the arrangement by which a succession of teeth is secured. What are the remarks of Professor Owen on this subject? What specific characteristics are represented by the teeth? What organic remains are found in Europe along with the teeth of the Mammoth? What hypothesis was started to explain the occurrence of elephants' teeth in Europe? Why was this unsatisfactory? What conclusion was then arrived at? What extinct animals of the present Order lived at former periods in Britain? What remark is made by Owen?

Order Cetacea.—P. 427.—What are the external characteristics of the Cetacea? Into what groups were they divided by Cuvier? How are the carnivorous Cetacea arranged? (*Delphinidæ.*)—P. 427.—Is the Dolphin ever met with on the British coasts? What associations are connected with its name? What does Professor Bell say of its habits? What is said of those of the Common Porpoise? What is its length? What other species belong to this group? (*Physeteridæ.*)—P. 428.—What substance is procured from the Cachalot? In what state is it found in the living animal? In what situation is it placed?

What is the length of the Cachalot? What proof is mentioned of its strength? On what does it principally feed? (*Balænidæ.*) —P. 429.—On what does the Common Whale feed? Is it now abundant in the Greenland Seas? Why is the term "Whale-fishery" objectionable? What is the position of the tail? What is it in fishes? To what different purposes is it applied by Whales and by fishes? What is the superficial measurement of the tail in some of the larger Whales? To what pressure is the Whale when at great depths occasionally subjected? How is it rendered capable of resisting this pressure? In what way does this prevent the heat of the body from being dissipated? Does it increase the density of the animal, or not? What is the length of the Rorqual? What ancient tradition respecting the Whale is recorded by Milton?

Order Carnivora.—P. 432.—To what animals is this term now restricted? What are the characteristics of the Tiger? Of the Bear? Of the Seal? What number of species does this Order contain? Into how many families are they divided? Family I.—*Phocidæ.*—P. 433.—In what do the Seals resemble the *Cetacea?* In what do they differ from them? Where do they live? What number is supposed to be annually taken? How many species are found on these coasts? What lengths do they attain? II.—*Ursidæ.*—P. 433.—What are the most obvious peculiarities of the Bears? What is the principal food of the American Black Bear? What of the Polar Bear? Where is the Brown Bear found? Have any fossil remains of animals of this family been found in England? Is any living representative yet existing there? What is said of fossil remains of the same species? What does Professor Owen say of the antiquity of the Badger? III.—*Mustelidæ.*—P. 434.—What animals may be enumerated as giving an idea of the characteristic structure of the group? In what way has the Otter been made useful? In what particular does the Stoat resemble the Alpine Hare? At what altitude has the Ermine been found? IV.—*Canidæ.*—What animals belong to this family? What is supposed to be the source from which our domestic dogs have sprung? V.—*Felidæ.*—P. 435.—What animals are included in the family of the Cats? What effect have they on the numbers of the smaller mammalia? What animal is now the sole representative in these countries of this group? What was the "Great Cave Tiger?" What is Dr. Buckland's statement respecting the remains found in a cave at Kirkdale? To what countries are Hyænas now restricted? What is their food, and mode of using it? How many individuals, according to Buckland, must have lived in the Kirkdale Cave? On what animals did they feed? How is the fact of the occurrence on one small island of so many animals belonging to an extinct fauna, accounted for?

Order Insectivora.—P. 438.—What is the shape of the teeth? What British animals are the representative of the Order? *Soricidæ.*—What is the name popularly given to the Shrew? What are its habits? Is there any part of these countries where the Water Shrew is not found? *Erinaceadæ.*—P. 438.—Where is the Common Hedgehog found? How is it defended? What idle

tale is told of its robbing orchards? *Talpidæ*.—P. 439.—What are the most obvious peculiarities of structure in the Mole? Of what does its food consist? Is it dormant in Winter? What idea do its habits convey to the superficial observer? What to the naturalist?

Order Cheiroptera.—P. 440.—State the differences of structure in the wing of the Bat and in that of the bird? What is the meaning of the scientific term which is the name of the Order? How does the Bat progress if placed on the smooth surface of a table? What is said of its climbing? Of its flight? Of what use besides that of flight do the wings seem capable? What were the experiments of Spallanzani? What is said of leaf-like appendages on the nose? How many species are natives of Ireland? How many of England? Describe the teeth of the Vampire Bat? What does Mr. Darwin say of its biting horses? What is the expanse of the wings of the large Java Bat? What classic fable may have been suggested by some of these animals?

Order Quadrumana.—P. 443.—Why is the Order so named? In what particular are the American Monkeys distinguishable from those of the Old World? Where are the Lemurs found? What are their habits? What power of movement is possessed by the thumb? In what respect does this contrast with the Marmozet? In what part of the American continent are Monkeys most numerous? How is the tail used by many of them? What term has been proposed for those with opposable thumbs on the feet only? To what regions of the Old World are Monkeys restricted? What exception is there to this law? Are any species regarded with veneration? At what altitude in India is the Entellus found? By what names are the Monkeys of the Old World separated into three tribes? Baboons, what is the structure of their cheeks? What other structural peculiarities do they exhibit? In what manner do they move? What localities do they inhabit? Into how many genera are they divided? Monkeys, what are their structural peculiarities? In what attitude do they walk? How are the tails used? What is the colour of the face? Apes, in what points do they differ from Monkeys and Baboons? What is their attitude and mode of progression? To what part of the world are they limited? Is there any exception to this? Which of the Monkey tribes evinces the greatest degree of intelligence? How many species of Monkeys are known? What proportion does this bear to the entire number of Mammalia? In what countries have their fossil remains been found? What evidence is there of their having lived in England? What proof is there that the climate must at that time have been warmer than now?

Order Bimana.—P. 448.—What are some of the most obvious external characteristics of Man? In what respect does the hand present another characteristic? What does Sir Charles Bell say of the hand? What is the meaning of the term *Bimana?* What position does Man occupy in the animal creation? State the results of zoological study on the mental faculties. What other advantages does it confer?

INDEX TO PART I.

PAGE

ACALEPHÆ 80
Acephala 162
Acheta 114
Acorn-shells 70
Actina mesambyanthemum ... 23
Actiniidæ 24
Agrion 117
American blight 141
Ammonites 185
Annelids 59
Ants, communities of..... 123
——, torpid in winter..... 124
ANNELLATA..... 59
Aphides, their saccharine secretion 123
——— ravages—reproduction ... 141
Aphis lanigera 141
Aphrodita 66
Aphrophora 141
Apis papaveris 128
Aplysia 179
Aporrhais pes pelicani..... 159
APTERA 148
ARACHNIDA 150
Arenicola piscatorum 64
Argonaut 187
ARTICULATA..... 57
Asaphus caudatus 77
Ascaris lumbricoides..... 13
ASCIDIODA 26
Ascidia communis..... 163
ASTEROIDA 20
Asteridæ..... 48
Avicula margaritacea 169

B

Barnacles, fables connected with.. 69
———, their transformations.. 70
Balanus 71
Bed-bug 143
Bee-bread 132
Bees, solitary and social..... 127
——, artisans..... 128
——, communities of..... 129
Beroë 33
Belemnite 186
Biphora 165

PAGE

Boat-fly 142
Bolina Hibernica 35
Bombus 129
Bombyx Mori 138
Botrylli 164
Bots..... 147
BRACHIOPODA 165
Buccinum 154, 182
"Buckie" 182
Burying Beetle 111
Butterflies 133
——— their transformations.. 100

C

Caddis-worms 118
Calamary 185
Calcosoma 111
Calymene Blumenbachii... 77
Cancer pagurus 79
Carabus 57, 104
Carcinus mœnas 83
Carpenter Bees 127
"Catydids" 140
Centipede 148
CEPHALOPODA 184
Cestum Veneris 40
Chiton..... 178
Chrysalis 100
Cicada..... 140
Cicindela campestris..... 109
Ciliobranchiata 28
Cimex lectularius 143
CIRRIPEDA 68
Clio borealis 175
Coccus Cacti 142
Cock-chafer 110
Cock-roaches 114
COLEOPTERA 107
Comatula rosacea 46
Coral Reefs 25
Cowry..... 156
Crangon vulgaris..... 88
Cribella oculata 44
Crinoidæ 45
CRUSTACEA 72
Crab, edible species of..... 83
Cray-fish..... 86

PAGE

Crickets, sense of hearing in 98
——— habits 113
Cuckoo Spit..... 140
Culex 146
CUTTLE-FISH 184
Culicidæ 146
Cydippe pomiformis 33
Cyanea aurita 37
Cyclobranchiata 177
Cyclops quadricornis..... 89
Cynipidæ 120
Cyprea 160
Daphnia pulex..... 90

D

Dead Sea Apples 121
Death's-head Moth..... 136
Death-watch 107
Diphya elongata 31
Dibranchiata 185
DIPTERA 143
Dog-whelk..... 182
Dor-beetle, sense of smell in 47
——— flight—habits 108
Dragon-fly, its power of flight 105
——— transformations—habits 116
Drone Bee 130
Dytiscus marginalis 107

E

Earth-worm 61
Echinus 50
ECHINODERMATA 42
Emperor Moth 137
Encrinite 45
Encephala 162
ENTOZOA..... 11
Eolis 177
Ephemera..... 119
Epeira fasciata 153

F

Feather-star 46
Field-crickets, Song of 98, 114
"Five-fingers" 49
Flesh Flies 144
Flea..... 150
Flustra carbasea 28
Fusus antiquus..... 157

G

Gad-flies 145
Gall-flies 120
GASTEROPODA 176
Geotrupes stercorarius..... 87, 109
Gigantic Cuttle-fish 191
Glow-worm..... 107

PAGE

Gnats, their transformations 100
——— alarm caused by..... 146
——— multitudes of 147
Gordius aquaticus 67
Gorgonia flabellum 21
Gossamer..... 153
Grasshopper..... 112
Gyrinus natator 98

H

Hair-worm 67
"Harry Long Legs" 146
Hawk-moths 136
HELIANTHOIDA 22
Helices 181
HEMIPTERA 139
Hermit Crabs 84
Hirudo medicinalis 59
Hive Bee..... 129
Hæmopsis sanguisuga..... 61
Holothuria 54
Homarus vulgaris 85
Honey-dew 123
Horse-Leech 61
House-flies 144
Humble Bees..... 129
Hyas aranea..... 82
Hydra 15
HYDROIDA 15
HYMENOPTERA 119

I

Ichneumonidæ 121
Ichneumon 121
Imago 100
INFUSORIA 4
INSECTS 92
Isis hippuris 22

J

Jelly-fish 30
Julus 148

K

King-crab 81

L

LAMELLIBRANCHIATA..... 166
Land-crabs 80
Larva 100
Leaf-cutter Bees 128
Leaf Insects 112
Leaf Rollers 137
Leech 59
Leg-of-mutton Shell 159
Lepas anatifera..... 69, 70
LEPIDOPTERA..... 133
Lepisma 149
Lernæa 91

PAGE

Libellulæ 105, 116
Limulus 81
Limnoria terebrans. 90
Limpet, quantity used as food..... 177
——— structure and habits 177
Lobster 85
Lob-worm or "Lug" 64
Locust..... 115
Loligo 185, 181
Loligopsis 185
Louse 149
Luidia fragilissima..... 49
Lumbricus..... 62
Luminosity in Polypes 20
——— in Beroës 35
——— in Medusæ 40
——— in Annelids 67

M

Machilis 149
Madrephylliæa 24
Mantis..... 113
May-flies 117
Medicinal Leech 59
Medusæ 145
——— their development 37
——— their watery structure..... 39
Melolontha vulgaris 110
"Midges" 146
Millipede 146
Mites 150
Mollusca 155
Mollusca of Ægean Sea 193
Moths 135, 137
Mosquito..... 144
Murex..... 183
Musca 144
Muscidæ..... 143
Mussel 170
Mygale cæmentaria.. 153
Myriapoda..... 148

N

Nais..... 63
Nautilus, the Pearly 184
———, the Paper..... 187
Nematus, grossulariæ 120
Nemertes, Borlassii 66
Nemertina..... 66
Nepa 94, 142
Nereis 65
Neuroptera 116
Notonecta 142
Nudibranchiata 177
Nut Weevil 110

PAGE

Oak-leaf Moth 124
Octopus 189
Œstrus 146
Oniscus 76
Ophiura 47
Orthoceratites..... 185
Orthoptera 112
Oyster..... 167

P

Pagurus Bernhardus 84
Palæmon serratus..... 88
Palinurus vulgaris 86
Paludina muriatica 158
Paper Nautilus 187
"Paps" 163
Parasita 149
Pea-crabs 84
Peacock Butterfly 133
Pearly Nautilus..... 184
Pearls 169
Pearl Oyster 169
Pearl Divers 169
Pecten maximus..... 170
Pelagia 30
Pennatulidæ..... 20
Pentatoma 139
Periwinkle 171
"Pilcrabs," 84
Pholas 173
Phryganeæ..... 117
Phyllium 112
Physalia 31
Pinna, crab found in shell of..... 84
——, its silk, and uses of 170
Pinnotheres pisum 84
Planorbis 180
Plant-lice 123, 141
Plumatella 27
Plumed moth 134
Podura..... 149
Polygastrica 6
Portuguese Man-of-war 31
Poulp 189
Prawn..... 88
Pteropoda 175
Ptinus..... 107
Pulex..... 150
Pulmonata 179
Pupa 100
Purpura lapillus 182
Pyralis..... 99
Pyrosoma 164

R

Radiaria..... 29
Radiata 3

	PAGE
Red Coral	22
Rhizostoma	36
Rotifera, what they are	6
———, organization—vitality	8
S	
Sacred Beetle	109
Salpæ	165
Sand-hoppers	89
Sand-star	47
Sand-wasp	126
Saturnia pavonia minor	137
Saw-flies	120
Scallop, used by pilgrims	157
———, power of movement	170
Scolopendra	148
Scorpion	151
Sea anemone	22
——, reproduction of lost parts	24
Sea-cucumber	34
Sea-fans	21
Sea-hare	179
Sea Long-worm	66
Sea-mats	28
Sea-mouse	66
Sea-nettles	30
Sea-pens	20
Sea-urchins	50
Sepia	185
Serpula	65
Sertulariadæ	18
Shells of Infusoria	10
Shells, Structure of	192
Shrimp	88
Silk-worm Moth	138
Sipunculidæ	55
Slugs and Snails	179
Sphinx of vine	136
Spiders	150
Spider-crabs	82
Spiny Lobster	85
Spio, Calcarea	68
Spirorbis	65
Spring-tails	149
Squilla	74
Star-fishes	42
Stylops	132
SUCTORIA	150
T	
Tabanidæ	145
Talitrus	89
Tapeworm	13
Tectibranchiata	178
Tenthredinidæ	119, 120
Terebratula	166
Terebella	64
Teredo	173
Termites	116
Tetrabranchiata	185
Thelphusa	80
THYSANOURA	148
Tipulidæ	146
Tongue of the Bee	131
Tortrix	137
Tridacna	157
Trilobites	77
Tripoli	10
Tubularia	17
Tubulibranchiata	182
TUNICATA	163
Turbo	171
Tyrian die	183
U	
Upholsterer bees	128
V	
Velella	31
Venerupis	173
Vermetus	182
Volute	156
W	
Water-beetle	107
Water-flea	90
Water scorpion, respiration in	94
———, colours of	142
Wasps	125
Wax	132
Weevil	110
Whelk, used as food	171
——, its habits; use as bait	182
Whirl-gig	98
Wood-louse	76
X	
Xiphosura	82
Xylocopa	127
Z	
Zoea	79
Zoology	1
ZOOPHYTA	14
Zostera	67

INDEX TO PART II.

PAGE

Acanthias vulgaris 215
ACANTHOPTERYGII 222, 241
Accipiter fringillarius 323
Adder 263
Adjutant 300
Affection of Birds for their Young 303
Air-bladder 203
Alca arctica 361
Alcedo Ispida 344
Alces palmata 401
Alcidæ 361
Alligators 269
Alligator lucius 271
Alpine Hare 391
Amblyrhyncus 265
American Black Bear 418
American Monkeys 427
Ammodytes Lancea 225, 229
AMPHIBIA 251
Amphioxus lanceolatus 223
Anas segetum 358
—— *albifrons* 358
Anatidæ 358
Anglesey Morris 218
Anguilla acutirostris 230
Anguillidæ 229
Anguis fragilis 264
Ant-eaters 377, 392
Antelopes 403
Anthus 332
Antelope 403
Apes 431
Apteryx 352
Aptinodytes demersa 361
Aquila nævia 315
—— *chrysœëtos* 315
Ardea cinerea 353
Ardeidæ 353
Armadillo ..... 371, 393, & note 397
Arvicola 388

PAGE

Asp 261
Asses 407
Astur palumbarius 323
Auchenia 401
Aurochs 405
Australian Water Rats 377
AVES 281
Avocet 294
Axolotl 251

B

Baboons 430
Badger 418
Baleen 376
Baleen Whale 413
Ballan Wrasse 241
Bank Martin 346
Barbary Baboon 429
"Barnacles" 358
Barn-door Fowl 347
Barn Owl 325
Basking Shark 226
Batrachia 251
Bats 373, 424
Baya 305
Bean Goose 358
Beaver 391
Bee-Eater 344
Bernicle Goose 358
Bills of Birds 294
BIMANA 432
BIRDS 281
Birds of Paradise 290, 335
Bison 404
Bittern 307, 354
Black Swan 359
Black-headed Gull 363
Black Grouse 349
Bleak 240
Blenny 241

PAGE

Blind-fish 202
Blind-worm 264
"Blubber" 414
Blue Shark 226
Blue Skate 241
Boa Constrictor 260, 262
Bonito 243, 244
Bos 404
Botaurus Stellaris 354
Bottle-head Whale 412
Bradypus 393
Bream 240
Brent Goose 358
Brown Bear 418
Buffalo 404
Bufo vulgaris 254
—— *calamita* 254
Bullfinch 334
Buntings 334
Bustards 351
Butcher-birds 328
Buteo vulgaris 323
Buzzard 323

C

Casing Whale 412
Cachalot 412
Camel 372, 401
Camelopardalis 403
Camelus 401
Canidæ 419
Capercaillie 351
Capra 403
Caprimulgus Europæus .. 328, 345
CARNIVORA 416
Carrier Pigeon 348
Carp 212, 219, 240
CARTILAGINOUS FISHES 223
Cassowary 284, 352
Castor Europæus 392
Cat 420
Caymans 269
Cervus 401
—— *capreolus* 403
—— *dama* 403
—— *elaphus* 403
Cepola rubescens 242
CETACEA 411
Chameleons 267
Chamois 403, 404
Charadriidæ 352
Charadrius pluvialis 352
Chelonia imbricata 275
—— *mydas* 275
Chimpanzee 376, 431
CHEIROPTERA 424

PAGE

Cholic-stones 220
Chough 338
Ciconia alba 355
Cinclus aquaticus 329
Circulation in Fishes 207
—— in Reptiles 250
—— in Birds 287
—— in Mammals 370
Cirri 200
Classification of Birds 308
Climbing Birds 341
Clupea alba 234
—— *sprattus* 234
—— *pilchardus* 234
—— *harengus* 335
Clupeidæ 233
Ctenoid Fishes 246
Cobra-di-Capello 261
Cock-of-the-Woods 351
Cockatoo 341
Cod-fish 203, 213, 233
Colossochelys Atlas 279
Columba Palumbus 347
—— *Livia* 348
—— *turtur* 349
—— *migratoria* 349
Columbidæ 347
Colymbus glacialis 360
Common Bat 424
Common Whale 413
Condor 299, 313
Conger Eel 229
Coot 356
Cormorant 295, 362
"Corn-crake" 356
Corvidæ 337
Corvus Cornix 338
Corvus frugilegus 338
"Coulter-neb" 361
Covering of Fishes 199
Crane 353
Crocodiles 269
——, Teeth of 270
Crop of Fowl 295
Cross-bill 334
Crotalus 259
"Cuckoo Gurnard" 244
Cuckoo 342
Cuculus canorus 342
Curlew 355
Cushat 347
Cycloid Fishes 246
Cyclopteridæ 231
Cyclopterus Lumpus 213, 231
CYCLOSTOMI 221
Cynocephalus 431
Cyprinidæ 240

PAGE

Cyprinus auratus 240
——— *carpio* 240
Cypselus murarius..... 346
Dactylopterus 245
Dasypus 393
Daws 340
Deer..... 375, 402
Delphinidæ 411
Delphinus delphis 411
Dentirostres 328
Didelphidæ 385
Digestive Organs in Birds 294
Dinornis 367
Divers..... 360
Diodon 198
Dodo 366
Dog 376, 419
Dog-fish 215, 225
Dolphins 377, 411
Domestic Hen..... 347
Dory 220, 243
Dromedary 401
Duck 294

E

Eagle Owl 325
Eagles 286, 287, 315
Ear-bones 201
Echeneidæ 231
Echeneis remora 221
Echidna 384
Echiodon 243
EDENTATA 392
Eels 197, 203, 212, 219, 229
——, their migration 230
——, susceptibility to cold..... 230
Egyptian Vulture 312
Eider Duck 359
Electric Ray 218
Elephas, primigenius 409
Elephant, neck of..... 373
———, trunk of..... 374
———, tusks of..... 375
———, food and teeth of..... 407
———, extinct native species ... 410
Elk 401
Eyes of Fishes 201
Emydæ 276
Entellus 430
Erinaceus Europæus 422
Erinaceadæ 422
Ermine 419
Esocidæ..... 239
Exocœtus volitans 206
Eyrie of Eagle 318

F

Falconidæ 314

PAGE

Falcons 314
Falco peregrinus 319
Fallow Deer 402
Feathers 287
Felidæ 420
Ferret 419
Fiddle-fish 198
Fifteen-spined Stickleback... 214, 244
Finches 334
Fins, how named 204
Fish Lizard 271
Fishing Frog, or Frog Fish... 210, 241
Fisheries, Improvement of 247
FISHES 197
Fissirostres 344
Flamingo 357
Flight of Falcon 321
——— Pigeon 349
Fly-catchers 329
Flying Fish 206, 214
Fox 420
Fox Sharks 217
Fregilus graculus 338
Frigate-bird 290
Fringillidæ 334
Frog 252
Fulica atra 356
Fulmar Petrel 365

G

Gadidæ 232
Gallinulla Chloropus 356
Gammarus 205
Gannet 291
Ganoid Fishes 246
GAPING-BILLED BIRDS 344
Gasterosteus 214, 216, 244
Gavials 269
Gavialus Gangeticus 271
Gazelle 403
Gecko 266
Geese 358
Geographical Distribution of Birds 308
Giant Armadillo 393
Giraffe 373, 374, 403
Globe-fish 198, 228
Glossy Ibis 355
Goat 375, 403
Goat-sucker 328, 345
Gobies..... 241
Gobioidæ..... 241
Golden-crested Wren 332
Golden Eagle 316
Golden Carp 240
Golden Plover 352
Gold-fish..... 198, 201, 240
Goldfinch 304, 334

PAGE

"Good Wives" 241
Gos-hawk 323
GRALLATORES 351
Great Cave Bear 418, 421
Great Cave Tiger 420, 421
Great Northern Diver 360
Grebes 360
Green Turtle 276
Grey Skate 241
Griffon Vulture 312
Gros-beaks 334
Grouse 349
Gruidæ 353
Grus Cinerea 353
Gudgeon 240
Guillemots 361
Gulls 362
Gurnard 203, 244

H

Haddock 232
Halcyon 344
Hake 232
Halcyonidæ 344
Haliæëtus albicilla 315
Hammer-head Fish 198
Hamster 390
Hares 377, 391
"Hassars" 213
Hawk's-bill Turtle 275, 276
Hearing in Fishes 201
Hedge Sparrow 343
Hedgehog 371, 422
Hen Harrier 323
Heron 353
Herring 218, 233
——— migration of 235
Herring-Gull 363
Hippocampus 228
Hippopotamus 406, 409, 410, 421
Hirundinidæ 345
Hirundo rustica 345
——— *urbica* 345
——— *riparia* 346
Hollow-horned Ruminants 375
Honey Buzzard 323
Hooded Crows 338
Hoonuman 430
Hornbill 341
Horse 406
House-Martin 302, 345
Howlers 429
Humming-Birds 286, 332
Hyæna 420
Hybernation 389
Hyperoodon 412

PAGE

Hystricidæ 387

I

Ibis 294, 355
Ichthyosaurus 271
Iguana 266
Iguanodon 266
Incisor Teeth of Rodentia 388
INSECTIVORA 422
INSESSORES 326
Irish "Elk," weight of antlers 375
———, distribution 402
———, with other fossils 421
Irish Hare 391

J

Jackdaw 340
Jay 307, 337
Jer Falcon 320
Jerboa 390
"John Crow" 298

K

Kangaroos 381, 383, 384, 385
Kashgow 400
King-fish 220
King-fisher 344
Kite 323
Kittiwake 363

L

Labridæ 241
Labrus maculatus 241
——— *Labyrinthodon* 257
——— *Lacertidæ* 268
——— *Lacerta agilis* 268
Lagopus mutus 350
Lammergeyer, or Lamb-Vulture 314
Lamprey 223
Lancelet 211, 223
Land Tortoises 277
Laniadæ 328
Lapwing 353
Laridæ 362
Larks 334
Larus argentatus 363
——— *ridibundus* 363
——— *canus* 364
Lemurs 428
Leopard 420
Lepidosiren 245
Ling 232
Linnet 334
Lion 420
Lissotriton punctatus 255
Little Bustard 351

PAGE

Lizards 265
Llama 401
Lophiadæ 241
Lophius piscatorius 241
LOPHOBRANCHII 221, 228
Loxia socia 306
Lump Sucker 213, 231
Lampris guttatus 220
Lycian Tortoises 280

M

Macaws 341
Mackarel 204, 218, 244
Mackarel Midge 219
Macropodidæ 384
Magpie 305, 307, 337
"Maids" 241
Maigre 219
MALACOPTERYGII APODES 229
——————SUB-BRACHIALES 233
——————ABDOMINALES .. 233
MAMMALIA 369
Mammoth 375, 409, 421
MAN 432
Man-of-War Bird 289
"Manikeeper" 255
Marmot 389
Marmozet 429
Marsh Tortoises 276
Marsupial Pouch in Pipe-fish 228
MARSUPIATA 381
Mastodon 410
Malepterurus 217
Meadow Pipit 343
Megatherium 395
Megatherioid animals 395
Meles Taxus 418
"Mermaids' Purses" 224
Merulidæ 329
Missel Thrush 329
Meropidæ 344
Mice 387
Migration of Birds 301
Milvus Ictinus 323
Minnow 240
Mocking-Bird 307
Molar Teeth of Ruminants 400
Mole 422, 423
Monkeys 427, 431
Monodon monoceros 412
Monotremata 383
Moschus 401
Motacilla 332
"Mother Carey's Chickens" 364
Moulting 293
Moose Deer 401
Mugil chelo 241

PAGE

Mugilidæ 241
Mullet 241, 245
Mullus surmuletus 245
Muridæ 387
Merian's Opossum 386
Mus messorius 388
Muscicapidæ 329
Musk Deer 401
Mustela erminea 419
Mustelidæ 419
Mylodon robustus 395

N

Naja 261
Narwhal 377, 412
NATATORES 356
Natrix torquata 259, 263
Natter-jack Toad 254
Naucrates ductor 243
Neophron 312
Nests 304
Newts 255
Nightingale 331
Nocturnal Lizards 266
Number of Mammalia 380

O

"Old Wife" 241
Opah 220, 243
OPHIDIA 258
Opossums 381, 382, 383, 385, 386
Orang Outan 376, 431
Orders of Birds 310
Orders of Mammalia 379
Organs of Voice in Birds 306
Ornithoryncus 383, 384
OSSEOUS FISHES 228
Ostracion 200
Ostrich 287, 351
———, its digestive powers 297
Otis tarda 351
—— *tetrax* 351
Otolites 201
Otter 419
Oustiti 429
Ovis polii 404
—— *burrhel* 404
Owls 307, 324
Ox 404

P

PACHYDERMATA 405
Pamir Sheep 404
Panther 420
Papio 431
Parr 239

PAGE

Parrot 294, 307, 341
Partridge 350
Parus 332
Passenger Pigeon 349
Pea or Roe 212
Pedimana 429
Pelican 295, 361
Peregrine Falcon 319
Pelius berus 263
Penguin 286, 287, 361
Perca fluviatilis 245
Perch, vitality of 197, 218
——, skeleton 204, 222
——, number of ova 213
——, habits of 245
PERCHING BIRDS 326
Percidæ 245
Perdix cinerea 350
——— *coturnix* 350
Pelecanidæ 361
Petrels 362
Petromyzidæ 223
Peewit 353
Phalacrocorax carbo 362
Phalangistidæ 385
"Pharaoh's Hen" 312
Phasianidæ 349
Pheasant 349
Phoca vitulina 417
Phocidæ 417
Phocæna communis 412
——— *melas* 412
Phœnicopterus 357
Phycis 213
Pied Wagtail 343
Pike 212, 239
——, longevity of 240
Pilchard 234, 235
Pilot-fish 243
Pipe-fishes, covering of 200
———, movements 205
———, mouth 211
———, marsupial pouch 228
"Piper" 244
Pipits 332
PISCES 197
Placoid Fishes 246
PLAGIOSTOMI 221
Plaice 203, 232
Platessa 232
PLECTOGNATHI 228
Plesiosaurus 271
Pleuronectidæ 232
Plover 352
Polar Bear 413
Pollan 236
Porcupine 371

PAGE

Porpoise 412
Pouched Adjutant 300
Pristis 216
Procellaria glacialis 365
Proteus 251
Ptarmigan 350
Pterodactyles 272, 273
Puffin 361
Puffinus cinereus 366
Puma 420
Python 262

Q

QUADRUMANA 427
Quadruped 372
Quail 350

R

Rabbit 377
Raia batis 241
Rails 356
"Rainbow Wrasse" 241
Rallidæ 356
Rana temporaria 252
RAPTORES 311
Rasores 347
Rass 404
Rats 387
Rattle-snake 259, 260
Raiidæ 224
Raven 337
Red Deer 403
Red Grouse 349
Red-legged Gull 363
Red Mullet 203
Red Riband-fish 198, 242
Rein-deer 400
Remora 221, 231
Removal of Decaying Animal Matter 300
REPTILIA 249
Respiration in Fishes 207
——— in Reptiles 250
——— in the Frog 254
——— in Birds 286
——— in Mammals 369
Ring-Dove 347
"River-horse" 406
River Tortoises 276
Rhinoceros, horn of 374
———, distribution 406
———, extinct species 409, 410, 421
Rhombus maximus 232
Robin Redbreast 330
Rock-Dove 348
RODENTIA 386
Roebuck 403

PAGE

Rook 305, 307, 338
Round-headed Porpoise 412
Rorqual 415
Rudd 240
RUMINANTIA 398

S

Salamandridæ 255
Solea vulgaris 232
Salmon 237
—— Migration of 237
—— Fishing 238
Salmonidæ 236
Sand Eels 229
Sand Launce 225
Sand-Martin 346
Sand-piper 355
Sarcoramphus gryphus 313
SAURIA 265
Saurians, Extinct species of 271
Saw-fish 216
Scales of fishes 199
SCANSORES 341
Scarus 207
Sciæna aquila 219
Sciuridæ 387
Sciurus vulgaris 391
Scolopacidæ 355
Scolopax rusticola 355
Scomber scomber 244
Scomberidæ 243
Scraping Birds 347
Scyllium canicula 225
Sea Bream 244
Sea-Devil 241
Sea-Horse 228
Seals 417
"Sea-parrot" 361
"Sea-purse" 224
"Sea swallows" 362
Sea-Unicorn 412
Serpents 258, 264
Sharks 225
Sheep 403
Shrikes 328
Shrew 422
Sight in Fishes 201
—— in Birds 298
Silurus 217
Simiadæ 430
Skate 215
Sky-lark 304, 333
Sloth 393
Slow-worm 264
Small Spotted Dog-fish 225
Smell in Fishes 201
—— in Birds 298

PAGE

Snake, Common 263
Snipe 294, 355
Snowy Owl 325
Sociable Grosbeak 306
"Soft Tortoises" 276
Solan Goose, power of flight 291
——, taken in fishing-nets 361
Sole 203, 232
Solid-horned Ruminants 375
Song Thrush 329
Somateria mollissima 359
Soricidæ 422
Sparidæ 244
Sparrow-hawk 323
Sparrows 334
Spermaceti Whale 412
Spider-Monkeys 429
Spined Dog-fish 215
Spotted Eagle 315
Sprat 234
Squalidæ 224
Squirrel 387, 391
Stag 374
Starling, its imitative powers 307
——, migration—numbers 334
Stickle-back 244
——, common 216
——, 15 spined 214, 244
Stoat 419
Stork 355
Stormy Petrel 364
St. Peter's Fish 220
Strigidæ 324
Strix flammea 325
Struthionidæ 351
Sturgeon 211, 227
STURIONIDÆ 227
STURNIDÆ 334
Sturnus vulgaris 334
Swallow 289, 345
Swan 282, 358
Swift 286, 295, 346
Swim-bladder 203
SWIMMING BIRDS 356
Swine 406
Sword-fish 216, 243
Sylvia sutoria 305
—— *Rubecula* 330
—— *Luscinia* 331
—— *Regulus* 332
Sylviadæ 330
Syngnathus acus 205, 228

T

Tadpole of Frog 252
—— of Newt 255

PAGE

Tail of Whales 414
Tailor-bird 305
Talpidæ 422
Tapir 374, 406
Teal 359
Teeth in Fishes 211, 226
—— in Mammalia 376
—— of Elephant 407
Temperature of Fishes 197, 244
———— of Reptiles 250
———— of Birds 286
———— of Mammals 369
Tench 212, 240
Terns 362
TESTUDINATA 273
Testudinidæ 277
Tetrao Scoticus 349
——— *Urogallus* 351
Tetraonidæ 349
Thalassidroma pelagica 364
Thrushes 329
Thynnus pelamys 243
——— *vulgaris* 243
Tiger, ... 416, 420
Titmice 332
Toad, the common 254, 256
Tœnioidei 242
Tooth-billed Birds 328
Torpedo 218
Tortoises 273
——— Gigantic Fossil 278
Touch in Fishes 200
Trachinus draco 215
Tree-frog 254
Trionycidæ 276
Troglodytes Europœus 342
Trout 222, 236
Trunk-fish 200, 228
Tunny 243
Turbot 203, 232
Turdus viscivorus 329
——— *merula* 329
——— *musicus* 329
Turkey Buzzard 298
Turtle-dove 349
Tusks of Mammoth 375
Two-toed Sloth 394

U

Unau 394
Ursidæ 418

V

Vampire Bat 426
Vanellus cristatus 353

PAGE

Vertebrate Animals—what they are 195
————, how arranged 196
Vespertilio Pipistrellus 424
Viper 259, 263
Vitality of Fishes 218
Viviparous Blenny 212, 241
Voles 387
Vulture 285, 294, 311
Vultur fulvus 311
Vulturidæ 311

W

WADING BIRDS 351
Wagtails 332
Wart-Hogs 406
Water-hen 356
Water-mole 384
Water Ouzel 329
Weasel 419
Weepers 429
Weever 215
Whale 376, 413
Whalebone 376
White-bait 233
White-fronted Goose 358
White Grouse 350
White Owl 325
White Shark 225
White-tailed Eagle 315
Whiting 232
Widgeon 359
Wild-boar 406
Wild Geese 358
Wild Oxen 405, 421
Wild Swan 307, 358
Wolf 419
Woodcock 355
Woodpeckers 341
Wood-Pigeon 347
Wood-Quest 347
Wolf-fish 211
Wrasse 241
Wren 304, 342

X

Xiphias gladius 216

Y

Yak 400

Z

Zebra 407
Zeus faber 220
Zootoca vivipara 268

Stanley's familiar History of British Birds -

White's History of Selborne

Yarrell's British Birds

Macgillivray's do do

UC SOUTHERN REGIONAL LIBRARY FACILITY
A 000 048 010 3

ZOOLOGY
FOR
SCHOOLS